SCIENCE

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*THE SCIENTIFIC ASPECT OF MODERN MEDICINE.**

THE origin and development of medical science are contemporaneous with the origin and development of mankind. So long as man has been, so long has been disease; and whenever man has suffered, man has tried to heal. The foundations of medicine lie deep in that soil of common knowledge from which arose all the sciences, and throughout its history it has freely absorbed the discoveries of them all. From the first it has been, and it must ever remain, their common meeting-place. In proportion as its spirit and its methods have been scientific it has progressed toward ultimate perfection. Yet, notwithstanding the importance of science to medicine, from first to last medicine has been permeated by the pernicious influence of empiricism. A wise man once said that all true science begins with empiricism, and medical science is a striking example of this fact. But it made an early effort to free itself. The most brilliant epoch of Grecian history is marked no more immortally by the wisdom of Socrates, the histories of Herodotus, the tragedies of Æschylus, and the art of Phidias, than by the medicine of Hippocrates and his followers, for this represents the first re-

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corded endeavor—and a mighty endeavor it was—to break away from the empiricism of the earlier ages. But the science of the time was meager, and, however laudable the aim, the Hippocratic writings are full of empirical notions. From that time on, down through the ages, we find science and empiricism, like the good and bad principles in all natures and all religions, ever contending. And the struggle still continues. As Richard Hooker wrote more than three hundred years ago, so to-day do 'Empirics learn physic by killing of the sick.' The empiricism of to-day is not solely the method of osteopaths, christian scientists, and vendors of patent nostrums; it is found in the schools and the practice of legitimate medicine. At times it has surprising successes; but the struggle is an unequal one, and science is sure to be victorious. At no period of the world's history has the scientific idea in medicine been so aggressive and advanced so rapidly as during the past fifty years, and at no time has it seemed nearer its ultimate victory than at this beginning of the twentieth century. This advance is so striking and so full of general interest that I have ventured to choose it as my subject to-day, under the title of 'The Scientific Aspect of Modern Medicine.'

The Idea of a Vital Force.—One of the most essential prerequisites of this advance was the complete and final liberation of medical science, and of all those sciences now comprehended under the general title of biology, from a burden which in one form or another had hampered progress from the earliest times. I mean the conception that living bodies possess within themselves an active force or principle, differing in nature from anything possessed by non-living bodies, and which represents the vitality of living things. The beginnings of this idea are found in the various forms of animism of savage races, according to which a spirit or ghost inhabits the body and is responsible for its actions. In diseased states, this good spirit is dispossessed by an evil one. In one form or another this belief is met with among all civilized peoples. It is found in the days of Salem witchcraft, and even as late as 1788, in Bristol, England, when seven devils were exorcised from an epileptic. In physiology, from the times of the early Greek medicine until after the Renaissance, the animistic idea is represented by the doctrine of the *pneuma,* or the 'spirits.' In Hippocratic times the spirits entered the body through the lungs, were carried by the blood to all parts, and enabled the vital actions to take place. At about 300 B.C., the Alexandrians found it convenient to make use of two forms of this mysterious agent, the 'vital spirits' residing in the heart, and the 'animal spirits' in the brain. To these, in the second century of the Christian era, Galen added a third, the 'natural spirits,' located in the liver.

All physicians of the present day are familiar with the remarkable story of Galen and his long reign in medicine. Born in the time of the emperor Hadrian, he lived an active life of medical research and practice. He was the imperial physician of Rome, and while the wise Marcus Aurelius was writing his 'Meditations,' Galen was producing his numerous medical books. These covered the whole field of the medicine of his time, much of which was the direct result of his own investigations. His activity was unparalleled, his knowledge immense, his logic and literary skill pronounced, and his system of medicine all-embracing. In these respects he was far above his contemporaries, and with the decline of the Roman civilization, the consequent disappearance of originality of thought, and the long unbroken sleep of research, what wonder is it that

his brilliance should shine unrivaled through the dark ages?

For more than a thousand years following the death of Galen, his authority in all things medical was supreme, and the doctrine of the *pneuma* was unchallenged. Only when there came the intellectual awakening of the Renaissance did men ask themselves whether Galen's books or the human body more nearly represented the truth. But it was even long after this that the *pneuma* was deposed, and when it fell it was only to give place to the *archæus* of that archcharlatan, Paracelsus, and to the *anima sensitiva* of the mystic philosopher, Van Helmont, and the melancholy pietist, Stahl. Through the latter part of the eighteenth and the early part of the nineteenth century the vital principle was still in control of the physiologists, but, as they learned more of the conservation and the transformation of energy in inanimate things, and more of the working of living bodies, the gulf between the inanimate and the animate gradually narrowed, and the supremacy of the laws of chemistry and physics in all things living became clearly recognized. It is true that at times in these latter days, sporadic upshoots of a neo-vitalism raise their tiny heads, but these are to be ascribed to the innate aversion of the human mind to confess its ignorance of what it really does not know, and they do not receive serious attention from the more hopeful seekers after truth.

The elimination from scientific conceptions of the idea of vital force made possible a rational development of the science of physiology, and in this way led directly to the growth of a scientific medicine. In one of his luminous essays Huxley has written: "A scorner of physic once said that nature and disease may be compared to two men fighting, the doctor to a blind man with a club, who strikes into the melée, sometimes hitting the disease and sometimes hitting nature." * * * The interloper "had better not meddle at all, until his eyes are opened—until he can see the exact position of his antagonists, and make sure of the effect of his blows. But that which it behooves the physician to see, not, indeed, with his bodily eye, but with clear intellectual vision, is a process, and the chain of causation involved in that process. Disease * * * is a perturbation of the normal activities of a living body, and it is, and must remain, unintelligible, so long as we are ignorant of the nature of these normal activities. In other words, there could be no real science of pathology until the science of physiology had reached a degree of perfection unattained, and indeed unattainable, until quite recent times."

No period has been so rich in physiological discoveries as the last fifty years of the nineteenth century. Research has developed along two main lines, the physical and the chemical, and to-day physiology is rightly regarded as the foundation stone of the science of diseases, and thus as the basis of scientific treatment.

The Cell Doctrine.—At the time when vital force was having its death struggle, the cell doctrine was being born. Inseparably linked with the idea of the cell is the idea of protoplasm—protoplasm the living substance, the cell the morphological unit. The heretofore mysterious living body is a complex mass of minute living particles, and the life of the individual is the composite life of those particles.

Within the past few weeks the world has bowed in mourning over the bier of an aged man who, more than forty years age, in the strength of his vigorous manhood, gave to medical science in a well-rounded form the best of the cell doctrine of his time. Rudolf Virchow need have performed no other service than this to have secured

worthy rank among the great men of medicine of the nineteenth century, for few books exercised a greater influence over medicine during that period than his 'Cellular Pathology.' From ancient times physicians had been divided into many camps regarding the cause of disease. One idea had been prominent for more than twenty centuries: The humoralists had maintained that pathological phenomena were due to the improper behavior or admixture of the liquids of the body, which were, in the original form of this theory, the four humors: blood, phlegm, yellow bile and black bile. According to the solidists, on the other hand, the offending agents were not the liquids but the solids, and especially the nervous tissues. Both humoralists and solidists were excessively speculative, and the growing scientific spirit of the nineteenth century was becoming impatient of hypotheses that could not be experimentally proved. The times were ripe for new ideas. Virchow, soon after taking the professor's chair at Berlin which he held from 1856 until his death, gave to an audience largely composed of medical practitioners, the lectures which, more than all else, have made him famous among his professional brethren. His main thesis was the cellular nature of all the structures and processes, whether normal or pathological, of all organized beings, and his dictum, '*omnis cellula e cellula*'—a cell arises only from an already existing cell is the keynote of his theories. With his microscope he demonstrated the cells in all the tissues of the body, whether normal or pathological, and he proved the origin of the morbid cells in the normal ones. As to processes, he maintained rightly that all parts of the body are irritable, that every vital action is the result of a stimulus acting upon an irritable part, and he claimed a complete analogy between physiological and pathological processes. Every morbid structure and every morbid process has its normal prototype.

Virchow's ideas aroused enthusiasm the world over, and were eagerly studied and largely accepted by progressive men of medicine. Time and research have corrected errors of detail, but no one now denies the cellular nature and physiological basis of pathological phenomena. These facts are fundamental to the understanding and treatment of disease, which is now universally regarded as the behavior of the body cells under the influence of an injurious environment.

Virchow's ideas regarding pathological formations are a fitting complement to the laws of the conservation and transformation of energy. In the living world, as in the non-living, the law of continuity holds good. There are no cataclysms, there is no new creation. Structure and energy, whether normal or abnormal, proceed from preexisting structure and energy. Only such a conception can make possible a scientific medicine, and, since its promulgation, medical advance has been rapid.

The Rise of Bacteriology.—During the past half-century, and largely during the past twenty-five years, that is, during the lifetime of this university, there has grown up a totally new science, comprising a vast literature and a vast subject matter, though dealing with the most minute of living things. This is the science of bacteriology. The achievements in this field have surpassed all others in their striking and revolutionary character, and bear both on the conception of the nature of a very large number of diseases, hitherto puzzling human understanding, and on their prevention and cure, hitherto baffling human skill. All other human deaths are few in number in comparison with those that have been caused by the infectious diseases.

Occurring the world over, constantly with us, invading all homes, and keeping the death rate in cities perpetually high, at times they have swept, with the fury of a fiery volcanic blast, over large regions of the earth's surface, sparing few, and leaving in their train empty households and cities of death. Recent statistics have claimed that one of these diseases, tuberculosis, alone kills one seventh of all the population of the world.

To what are these pestilential visitations due? Many have said, 'To the anger of offended gods'; others, 'To the displeasure of a divine Providence'; the early physicians, 'To a wrong admixture of the humors'; the later pathologists, 'To mysterious fermentations.' But none of these answers has touched the vital point. This was reserved for a simple, modest and earnest student of science, of humble origin, the son of a French tanner, a man unhampered by medical tradition, seeking only the truth, and possessed of no genius except the genius of perseverance. To Louis Pasteur, more than to all others, should be given the honor of having solved the problem of the causation of these dread diseases. He laid the foundations of the new science, broad and deep, with surprisingly few errors of judgment.

It is instructive to look at the leading features of Pasteur's life-work. From the beginning of his career, Pasteur was the defender of pure science, yet his work demonstrates well the ultimate practical value of what seems at first purely scientific. At the age of thirty-one he became a professor and dean of the Faculty of Sciences at Lille, and in his opening address he said to his students: 'You are not to share the opinions of those narrow minds who disdain everything in science that has not an immediate application.' And then he quoted that charming story of Benjamin Franklin, who when witnessing a demonstration of a scientific discovery, was asked: 'But what is the *use* of it?' Franklin replied: 'What is the use of a new-born child?'

Pasteur's various scientific labors form a strikingly connected series, each being logically bound to those that preceded it. Beginning with a study of the forms and significance of the crystals of certain salts, in which he made use of fermentation processes, he passed directly to the study of fermentation itself. He early appreciated the fact that this phenomenon, due as it is to the presence in fermentable liquids of microscopic living bodies, bears significantly on fundamental physiological processes; and his labors directly established the germ theory of fermentation. Fermentation led to his famous investigation of the problem of spontaneous generation, which for ages had vexed the scientific and popular mind. Organic liquids exposed to air soon become putrid and filled with microscopic beings, the origin of which was a mystery. Many believed them to originate spontaneously; others thought that the air contained a mysterious creative influence. 'If in the air,' thought Pasteur, 'let us find it'; and by the simple device of stopping the mouths of flasks of sterilized liquids by a bit of cotton-wool, he was able to filter out the influence and keep his liquids pure and free from life. At the end of a year's active work he announced a most important fact: 'Gases, fluids, electricity, magnetism, ozone, things known or things occult, there is nothing in the air that is conditional to life except the germs that it carries.' His position was assailed by clever men, and he was forced to defend himself. It was here that his power of perseverance first formidably asserted itself. The struggle lasted for years, and Pasteur repelled each attack, point by

point, with facts acquired by ingenious experimentation, with the ultimate result of giving to the doctrine of spontaneous generation its death blow.

Fermentation and spontaneous generation prepared Pasteur for his next victory. The French wine trade was threatened with disaster. Wines prepared by the accepted methods often became sour, bitter or ropy. It was said that they suffered from diseases, and the situation was critical. It was Pasteur's achievement not only to prove that the diseases were fermentations, caused not spontaneously but by microscopic germs, but also to suggest the simple but effective remedy of heating the bottles and thus destroying the offending organisms.

It seemed a long step from the diseases of wines to the diseases of silkworms, yet when a serious epidemic, killing the worms by thousands, threatened irreparable injury to the silk industry, it was only natural that Pasteur, with his growing reputation for solving mysteries by the diligent application of scientific method, should be called upon to aid. He responded with his customary enthusiasm, and for five years diligently sought the cause of the trouble and the cure. Though stricken by paralysis in the midst of his work, in consequence of which for a time his life hung in the balance, in three months he was again in his laboratory. Here, as in his previous labors, he achieved final success. He proved that the silkworms were infested with distinct diseases, due to easily recognizable germs. Furthermore, he devised efficient methods of eliminating the diseases, and thus he relieved from its precarious condition the silk industry of France and of the world.

By the year 1870 Pasteur's success had already assured him, at less than fifty years of age, a commanding place in the scientific world. His demonstrations of the all-important parts played by microscopic organisms in the phenomena which he had studied, had stimulated widespread investigation. He had already dreamed of the germinal nature of human diseases; and now medicine, which had long suspected them to be associated with fermentation processes, began to appreciate the significance of the new discoveries. In 1873 he was elected to fill a vacancy in the French Academy of Medicine, and from that time on he gave more exclusive attention to pathological phenomena. He investigated septicemia, puerperal fever, chicken cholera, splenic fever, swine fever, and lastly rabies. To speak at length of what he accomplished in this field would require much time. I would, however, mention one salient incident.

One day chance revealed to him a unique phenomenon, the further study of which led to one of his most significant discoveries. In the inoculation of some fowls with chicken cholera, not having a fresh culture of the germs, he used one that had been prepared a few weeks before. To his surprise, the fowls, instead of succumbing to the resultant disease, recovered, and later proved resistant to fresh and virulent germs. This was the origin of the pregnant idea of the *attenuation*, or weakening, of virus, which, nearly a hundred years before, Jenner unknowingly had demonstrated in his vaccinations against smallpox, and which had been employed by physicians in all the intervening time. By various methods of attenuation Pasteur succeeded in producing vaccines from the virus of several diseases, and he perfected the process of vaccinating animals and thus protecting them from attacks of the disease in question.

The story of Pasteur's brilliant investigations of hydrophobia is too recent and too well known to relate here. They form a fitting ending to a life rich in scientific

achievement, stimulating to research, and momentous in the history of scientific medicine.

In the summer of 1886 it was my good fortune to spend a few hours in the presence of this man in the rooms of the then newly organized Pasteur Institute in Paris. It was in the early days of the practical application of the results of his long-continued, devoted experimentation regarding the cause and treatment of hydrophobia. In a large room there was gathered together a motley company of perhaps two hundred persons, most of whom had been bitten by rabid animals. Men, women and children, from the aged to babes in the arms of their mothers, richly dressed and poorly dressed, gentle folk and rude folk, the burgher and the peasant; from the boulevards and the slums of Paris, from the north, south, east and west of France, from across the Channel in England, from the forests and steppes of Russia where rabid wolves menace, from more distant lands and even from across the seas—all had rushed impetuously from the scene of their wounding to this one laboratory to obtain relief before it was too late. All was done systematically and in order. The patients had previously been examined and classified, and each class passed for treatment into a small room at the side: first, the newcomers, whose treatment was just beginning; then, in regular order, those who were in successive stages of the cure; and, lastly, the healed, who were about to be happily discharged. The inoculations were performed by assistants. But Pasteur himself was carefully overseeing all things, now assuring himself that the solutions and the procedure were correct, now advising this patient, now encouraging that one, ever watchful and alert and sympathetic, with that earnest face of his keenly alive to the anxieties and sufferings of his patients, and especially pained by the tears of the little children, which he tried to check by filling their hands from a generous jar of bonbons. It was an inspiring and instructive scene, and I do not doubt that to Pasteur, with his impressionable nature, it was an abundant reward for years of hard labor, spent partly in his laboratory with test-tubes and microscopes, and partly in the halls of learned societies, combating the doubts of unbelievers and scoffers, and compelling the medical world to give up its unscientific traditions and accept what he knew to be the truth.

Modern Surgery.—The earliest practical application to human disease of the results of Pasteur's labors was made in the field of surgery. The horrors of the early surgery had been largely eliminated by the discovery of the anesthetic effects of chloroform and ether, and the possibility of their safe employment with human beings. But the successful outcome of an operation was still uncertain. No one could foretell when the dreaded septic blood-poisoning might supervene and carry off the patient in spite of the most watchful care. Many hospitals were only death traps, the surgical patient who was taken to them being doomed to almost certain death. The suffering of the wounded in our Civil War was extreme, and during the Franco-Prussian War, the French military hospitals were festering sources of corruption, their wounded dying by thousands. To Pasteur, who realized only too well that the cause of death lay in the germs that were allowed to enter the wounds from the outside, this unnecessary suffering and death of so many brave French youths was a source of intense grief. Yet, notwithstanding his protestations and the urging of his views upon those who were immediately responsible, little good was then accomplished, for the

French surgeons were slow to adopt new ideas.

In England Lister was more successful. Fired by Pasteur's discoveries regarding fermentation and putrefaction, he conceived the idea of using carbolic acid in the vicinity of the wound while an operation was being performed, for the purpose of destroying whatever germs might be floating in the air or adherent to the surfaces. This was employed successfully, and at once the mortality of surgical operations was greatly diminished. This was the beginning of the aseptic surgery of the present day, and, in the light of what it has accomplished, Lister's achievement shines with brilliance. Carbolic acid was soon discontinued, owing to more efficient aseptic agents and methods of absolute cleanliness, but the essence of the modern surgical method is the same as at first, namely, to prevent the living germs from entering the wound. Septicemia and pyemia are no longer to be dreaded, the successful outcome of surgical procedure is practically assured, and operations that were undreamed of twenty-five years ago are now daily occurrences in the hospitals of the world. The most remarkable are those that come under the general head of laparotomy, which requires the opening of the abdominal cavity, and those performed on the brain. It may be said that the greatest development of scientific or aseptic surgery has occurred in America. Here the typical American traits of ingenuity, independence and courage have borne good fruit.

Disease Germs.—Pasteur's work was epoch-making. Apart from its revolutionizing the methods of practical surgery, it has completely changed our conception of the nature and the mode of treatment of the whole group of germ or zymotic diseases, and has gone far toward solving a host of long-existing and puzzling problems of general pathology. The actual discovery of the germs of human diseases and the proofs of their specific morbific properties did not fall within Pasteur's province. Such achievement has been the lot of others, most brilliant among whom is undoubtedly Robert Koch. The bacillus of anthrax, or splenic fever, was seen in 1838 by a French veterinarian named Delafond, but its part as the causative agent of the disease was first shown by Koch in 1876, this being the first conclusive demonstration of the production of a specific human disease by a specific bacterium. Think how recent was this event, so significant for the development of a scientific medicine and for the welfare of the human race! Koch's demonstration was made but twenty-six years ago, eleven years after the close of our Civil War. But it was only after repeated subsequent experiments and the piling of proof on proof by Koch, Pasteur and others, that the new idea was generally accepted. Since then discovery has followed discovery, and the world watches eagerly for each new announcement. Koch acquired new laurels in 1882 by demonstrating the germ of tuberculosis, and in 1884 that of the terrifying Asiatic cholera. In 1884, also, Klebs and Löffler found the bacillus of diphtheria, and several investigators that of tetanus. The year 1892 revealed the bacillus of influenza, and 1894 that of bubonic plague. Besides these instances, the part played by specific germs in many other diseases has already become recognized. Smallpox, measles, hydrophobia and yellow fever still defy the investigators, but no one doubts their germinal nature.

But scientific medicine is not content with describing species of bacteria and proving their connection with specific diseases. It must show what these organisms do within the body, how they cause disease,

and by what procedure their evil activities may be nullified. Persistent and devoted research has already thrown much light on these problems, yet so much is still obscure that it is difficult to generalize from our present knowledge. The germs find lodgment in appropriate places, and proceed to grow and multiply, feeding upon the nutrient substance of their host. In certain diseases, if not in all, their activities result in the production of specific poisonous substances called *toxins*, which, being eliminated from the bacterial cells, pass into the cells of the host and there exert their poisonous effects. These effects vary in detail with the species of bacterium; and thus the individual, suffering from the behavior of his unwonted guests, exhibits the specific symptoms of the disease.

Preventive Medicine.—In looking over the history of the search for a means of cure, one is struck by the great value of the ounce of prevention. Keeping the germs out is in every way preferable to dealing with them after they have once entered the body. This fact scientific medicine is impressing more and more deeply on the minds of public authorities and the people, and their response in the form of provisions for improved public and private sanitation is one of the striking features of the social progress of the present time. All the more enlightened nations, states and cities of the world possess organized departments of health, which, with varying degrees of thoroughness, deal with the problems presented by the infectious diseases, in the light of the latest discoveries. Water and milk and other foods are tested for the presence of disease germs; cases of disease are quarantined; and innumerable provisions, unthought of fifty years ago, are now practised daily for the maintenance of the health of the people.

In the city of New York the Department of Health now undertakes, free of charge, examinations for the diagnosis of malaria, diphtheria, tuberculosis, typhoid fever and rabies. It treats all cases of rabies by the Pasteur method free of charge, and it supplies, at slight cost, diphtheria antitoxin and vaccine virus, besides mallein to aid in the diagnosis of glanders in horses, and tuberculin for similar use with suspected tuberculosis in cattle. Moreover, from time to time it issues circulars, intended for the education of physicians regarding the causation of infectious diseases and the newest methods of treatment; and through its officers and other physicians and by means of printed matter it endeavors to educate the people in matters of private sanitation. It requires official notification by public institutions and physicians of all cases, not only of the epidemic diseases, but even of tuberculosis. The benefits derived from these various prophylactic measures are seen in great decrease in mortality from the diseases in question. Much good is expected from the work of the newly organized Committee on the Prevention of Tuberculosis of the Charity Organization Society of New York, which, backed by financial resources, is about to undertake an active campaign to lower the death rate from this particular disease, and to lessen the suffering and distress attributable to it.

Fifty years ago the term preventive medicine was unknown. To-day it represents a great body of well-attested and accepted principles. It has cleaned our streets, it has helped to build our model tenements, it has purified our food and our drinking water, it has entered our homes and kept away disease, it has prolonged our lives, and it has made the world a sweeter place in which to live.

Serum Therapy.—But if the ounce of prevention has not been applied or has

failed, and the bacteria have forced an entrance into the body, what can scientific medicine do to cure? Two things are possible—the destruction of the destructive germs, and the neutralization of their poisonous toxins. The commonly recognized drugs here prove inefficient, for the simple reason that the amount of the drug sufficient to kill the bacteria is so great as to endanger the life of the patient. The most promising line of treatment has been suggested by the results of a study of the mutual relations of the bacteria and their hosts. Here again there are many gaps in our knowledge. It is not surprising that the cells of the body resent the intrusion of the barbaric horde of microorganisms, with their poisonous offscourings. The cells are roused to unwonted activity, and pour forth into the blood specific substances, which, in many cases at least, seem to be of two distinct kinds, the *cytolysins* and the *antitoxins*. Of these, the cytolysins are destructive to the invading bacteria, while the antitoxins are capable of neutralizing, though in a manner not wholly clear, the toxic products of bacterial growth. Cytolysins oppose the bacteria, while antitoxins oppose the bacterial toxins, and the outcome of the disease depends on the relative efficiencies of the contending forces. If the invaders prove too powerful for the body cells, the individual succumbs; if the defenders prevail, he recovers.

With the picture of this natural conflict before the mind, medical science asked: 'Is it not possible to aid the invaded body by providing it with weapons of the same kind as its own, but in larger quantity?' This question medical science has answered emphatically and affirmatively in the case of two serious diseases, diphtheria and tetanus, or lockjaw. By making a pure culture of their germs, and injecting their toxins into the bodies of animals, it can obtain a blood serum heavily charged with antitoxin. This when injected into the diseased human body supplements the antitoxin there found, and by so much the patient is aided in his struggle. With both these diseases the success of the serum treatment has been pronounced. A recent study of 200,000 cases in which the antitoxin of diphtheria was used shows the fatality from that disease to be reduced from 55 to 16 per cent. The problems presented by other infectious diseases seem to be more difficult. What seems to be required in most cases is a serum containing in quantity rather the cytolytic than the antitoxic substance, and as yet an efficient serum of this nature has not been found. Any day may yield such an one. But the matter of the relation of cytolysins and antitoxins, and their respective efficiencies in specific diseases, needs much elucidation. Serum therapy is in its infancy, but its methods appear so rational that it seems destined to develop into a most efficient branch of scientific medicine.

Second only in importance to the cure is the prevention of a future attack of the disease, or, in other words, the conferring of immunity on the individual. The disease itself, when running its natural course within an individual, confers a natural immunity against a subsequent attack, and with many diseases this may prove to be a life-long protection. Typhoid fever and smallpox, for example, rarely attack the individual a second time. In its present state the serum treatment also accomplishes immunity in some, though slight, degree, but greater and more lasting efficiency is desired. Probably no problem in bacteriology is being attacked more vigorously and more widely at the present time than this. A suggestive hypothesis by Ehrlich as to the chemical relations of the invading cells and the cells of the body has stimulated investigations in many

laboratories, and both the nature of immunity and the best method of accomplishing it, which have puzzled medicine so long, bid fair to become known in the near future. With this achieved, preventive medicine will have gained one of its greatest triumphs.

A word should here be said regarding two of the infectious diseases whose peculiar method of transmission, long a mystery, has now become known. I refer to malaria and yellow fever. The able work of Laveran, Manson, Ross, Grassi, Koch and others on the former, and that of Reed and other courageous Americans on the latter, have demonstrated conclusively that these diseases are transmitted from man to man through the aid of the mosquito, which, receiving the germ from an infected individual, cultivates it within its own body and later delivers it in a properly prepared form to another unfortunate human being. Moreover, it is entirely probable that this is the sole method of the transmission of these diseases. The ounce of prevention here consists in: first, eliminating from the community, so far as possible, the breeding places of the mosquito; secondly, totally preventing, by simple screens, the access of the insect to each case of the disease. By the employment of these simple methods in Havana, during the year ending with the end of last September, not a single case of yellow fever originated within the city, an event unparalleled in recent times. The active work now being carried on by the Liverpool School of Tropical Medicine on the west coast of Africa bids fair to reduce materially the extent of malarial fever, so long the scourge of that region.

It is impossible to predict the full outcome, in the future, of the diligent research of the past few decades in the field of the infectious diseases. Certain it is, that in civilized countries there appear no more the terrible epidemics of the past, such as the Black Death, which, in the fourteenth century, ravaged much of the continent of Europe, and in England swept away more than half a population of three or four millions. The struggle of the deadly germs for existence is becoming daily a more desperate one. Just as paleontology has revealed numerous instances of the annihilation of once flourishing species of organisms high in the scale of life, it is perhaps not visionary to look forward to the ultimate extinction of these more lowly forms, and, with them, to the abolishment forever from the face of the earth of the diseases which they cause.

The study of the microorganisms in the past and present bears upon a much wider range of subjects than the immediately practical one of the prevention and cure of individual diseases, however important that may be. It is constantly aiding, in ways surprising and unforeseen, in the solution of even long-standing and remote problems. I need only mention here that of the recognition of human blood as distinguished from that of lower animals. Moreover, this study has helped in the elucidation of many of the fundamental problems of protoplasmic activity, and has given men of medicine a broader culture and a higher outlook over the accomplishments and possibilities of the human organism. This cannot fail to react upon other fields than that of the infectious diseases, to make treatment in general a more rational matter than it has ever been, and to uplift the whole science of medicine.

Before finally leaving this subject, I would speak of the many instances of personal heroism exhibited by the men who have labored in this field. The records teem with stories of those who, recognizing more fully and intelligently than others

the dangers that surrounded them, and the deadly risks they were incurring, have, nevertheless, led by their great courage and scientific devotion, gone steadily forward, sometimes to death itself. There is danger in the laboratory and the hospital, and greater danger in the midst of epidemics. 'What does it matter?' replied Pasteur when his friends spoke of these perils, 'Life in the midst of danger is *the* life, the real life, the life of sacrifice, of example, of fruitfulness,' and he continued his labors. The death from cholera of a devoted and much-loved pupil of his at Alexandria, whither he had voluntarily gone to investigate the dread scourge of 1883, was a great grief to the master, but only intensified his devotion to his work. Since then many others have met an end as heroic, martyrs to the cause of medical progress. Among these I need only mention our own Lazear, who gave up his life in the yellow-fever laboratories in Cuba. Notwithstanding such tragedies, the laboratories and hospitals are always full of workers, and each new epidemic finds those who are eager to go to the scene to aid. The good to be performed and the honors to be won overcome the fears, and the ranks of laborers in this most deadly province of scientific medicine are never wanting in men.

Internal Secretion.—Leaving the subject of the infectious diseases, let me turn now to a mode of treatment based on recent experimental work, and applied successfully to certain unusual and grave maladies, which are evidently accompanied by disordered nutrition, but the cause and proper treatment of which until very recently were obscure.

About a dozen years ago the phrase 'internal secretion' began to be employed in physiological laboratories for the first time, and for a newly recognized function of glandular organs. It was well known that glands receive from the blood raw material, and manufacture from it specific secretions, which are discharged either outside the body for excretion, as is the case with the perspiration, or to the surface of mucous membranes for use in bodily function, as instanced by the gastric juice. It was discovered, however, that certain glands, such as the thyroid, the suprarenal, the pancreas and others, manufacture and return to the blood specific substances, differing with the different glands, but of important use to the body, and the absence of which leads to profound consequences. These substances were called *internal secretions.* Thus, removal or suspension of the function of the thyroid gland, and hence the loss of its internal secretion, reduces the body to a serious pathological state, long recognized by the name myxedema. Of similar causation is the peculiar condition, called cretinism, which is characterized by a physical and mental stunting of the growing individual. The rare Addison's disease is associated with disturbance of the function of the suprarenal glands; and other instances might be mentioned. It seemed a simple step from the discovery of the cause to the discovery of a cure. If absence of a substance is the cause of a disease, supplying that substance ought to effect a cure, and such was found to be the case. Administering to the afflicted individual the fresh thyroid gland of animals or a properly prepared extract of such gland, was found to alleviate or cure myxedema; and other instances of the efficiency of glandular products were recorded. So striking were the facts that active investigation of the matter was undertaken, with the result of showing that the chemical interrelationships of the various tissues of the body were profound, and a knowledge of them of exceeding value to

the physician. As a possible instance of this may be mentioned the idea, recently suggested by Professor Herter, of New York, that the suprarenal gland, by means of its internal secretion may control the manufacture of sugar by the cells of the pancreas, an idea which, if proved true, may bear significantly on the causation and treatment of diabetes. There is need of much research in this field of the internal secretions, but already glandular extracts have proved a valuable addition to the remedies of the scientific physician.

Brain Surgery.—I have already spoken of the entire change in the methods of general surgery during a period of twenty-five years, owing to the rise of bacteriology. But I ought to mention specifically the remarkable advance made during the same time in the surgical treatment of diseases of the central nervous system, the brain and the spinal cord, for it is here that the scientific method has achieved one of its most complete triumphs.

Although it was pointed out by the French surgeon, Broca, as early as 1861, that the loss of the power of speech is associated with disease of a certain portion of the left hemisphere of the brain, it was still the general belief that the acting brain acts as a whole. This idea prevailed until 1870, when the German physiologists, Fritsch and Hitzig, demonstrated that stimulation of different areas of the cerebral surface evoke in the body different movements. This was the beginning of the experimental investigation of *cerebral localization,* a line of research which has proved rich in results. The brain is not one organ acting as a whole, but an association of many organs, each with its specific duty to perform, but intricately associated with all the others. In the years that have passed since the discovery of Fritsch and Hitzig it has been the task of neurologists to discover the functions of the different parts of the central nervous system, to unravel their intricate interconnections, and to associate the disturbance of their functions with external symptoms in the individual. As a result of this labor the neurologist, after a careful study of his patient, now says to the surgeon, 'Cut there, and you will find the disturbing agent'—and the brilliant success of the brain surgery of the present day justifies its scientific basis.

The New Physical Chemistry.—In the early part of this address I spoke of the freedom with which medicine made use of discoveries in other sciences than its own. A very recent striking illustration of this is that of the application of the principles of the new physical chemistry to the phenomena of the living body. From the standpoint of physical chemistry the body may be regarded as a mass of minute particles of semi-liquid living substance, the protoplasmic cells, each surrounded by a thin permeable membrane, the cell-wall, and bathed externally by the circulating liquids, the blood and lymph. Both the protoplasm and the external liquid contain substances in solution, and whatever passes between them, be it food, or waste, or drug, must pass in the form of a solution through the intervening cell-wall. The laws of solutions and the laws of the passage of solutions through membranes must hence find their applications in the body. It has been the general belief that when a substance becomes dissolved its molecules remain intact, and are merely separated from one another by the water or other solvent. Quite recently physical chemistry has shown that this view is not altogether correct, but that a varying amount of disintegration takes place, a dissociation of the molecules into their constituent atoms or groups of atoms. Moreover, these dissociated particles, *ions,* as they have been called, are charged with electricity; some,

the *kations*, charged positively; others, the *anions*, negatively. Electrolytic dissociation is much more pronounced in solutions of inorganic than of organic substances. In proportion to its extent, specific properties are conferred on these solutions. What these properties are is not altogether clear, but it is entirely probable that the specific properties of many drugs are dependent, in part at least, on the amount of their dissociation when in solution. Furthermore, the amount of a given substance which is able to pass through a membrane is measured by the so-called *osmotic pressure* of the substance, and this, which varies with the concentration of the solution, seems to depend on the movements of the molecules and the ions within the liquid solvent. Since the physician, in the giving of a drug, wishes to induce certain cells of the body of his patient to absorb certain quantities of the drug, it is obvious that a knowledge of the principles by which substances pass through membranes will aid him.

The laws of solutions and the laws of osmosis still remain largely obscure, and because of this the literature of the subject contains much that is of little value—deductions from insufficient data, conclusions of one day which are overthrown by the researches of the next, fantastic imaginings which only throw discredit on the really worthy, and hopes buoyed up by the light of an *ignis fatuus*. But enough of truth has been already revealed to stimulate active research for the sake of physiological progress, and to show that the subject bears profoundly on the problems which the physician meets daily. It is partly along this line that the revitalized science of pharmacology, the study of the physiological action of drugs, which for several years has been actively pressing to the front, promises to make still more rapid progress in the near future.

Medical Schools.—The growth of scientific medicine, some of the branches of which I have thus tried to present to you, has reacted powerfully on our medical schools. The prominent features of this reaction are: the increase in the requirements for admission, the greater amount of laboratory and clinical instruction, the extension of the course in length, and the inclusion of the medical schools within universities.

Within a few years the requirements for admission to medical study have been raised from an elementary education, by many schools to that of a high-school course or college preparation, by a few to a partial college training, and by two to a full college course with a resulting bachelor's degree. As the wisdom of the latter is still not generally conceded, it is doubtful whether in the near future it will become widespread. Ideal as it seems, the one argument against it, that thereby the young man is forced to delay entrance to his life-work until a late age, has never been satisfactorily answered. President Butler's recent pronouncement in favor of a division of the college work into a two-year and a four-year course has much in its favor. This would allow a certain amount of those studies which are pursued for the purpose of general education and culture, and a grounding in the especially necessary chemistry, physics and biology.

The increase in the amount of laboratory and clinical instruction is merely in harmony with the truth that seeing is believing. 'Study nature, not books,' says Agassiz, and he might have added for the guidance of the teacher, 'Weary not your pupils with words, let them see things.'

In length the medical course has rapidly increased from two to three, and from three to four, years. With the increase in the number of hospitals throughout the land, and the opportunities offered therein to

recent graduates to serve as internes under competent visiting physicians, one or two years more may be added to the student's equipment, making a training of five or six years before the young doctor actually begins independent practice.

The inclusion of the medical schools within universities is one of the most important advances of medical education made in many years. Of the 156 schools existing in this country, 74, or nearly one half, are departments of colleges or universities. In this respect, however, America is still far behind Germany, for in the latter country no medical school exists except as a part of the larger institution. The advantages of such a connection are too obvious to dwell upon. Apart from the material benefits that are likely to accrue to the school, and the prestige granted it in the educational world, there is the atmosphere of a higher culture, a more scientific spirit, and less utilitarianism, which is breathed by instructors and students alike, and which cannot fail to make the graduates broader men. In the larger of these university schools a portion of the teaching body consists of men who do not engage in medical practice, but, like the instructors in the non-professional schools of the university, give their whole time to their specialties, in teaching and research. Usually these are the holders of the chairs of the non-clinical, basal sciences, anatomy, physiology, pathology, bacteriology, physiological chemistry and pharmacology. The outcome of this must be to broaden and deepen the scientific basis of medicine. The clinical branches are still taught by men who are at the same time private practitioners. In a recent thoughtful essay on 'Medicine and the Universities,' a professor in one of our leading medical schools urges the further severance of medical teaching and private medical practice. He would have internal medicine, surgery, obstetrics, and, indeed, all the principal clinical departments of instruction, placed like the fundamental sciences 'on a true university basis,' by which he means that the holders of these chairs should devote all their time and energy to teaching and research. This would require the paying of large salaries and the building of extensive university hospitals, wherein the professors could carry on their investigations. In my opinion the benefits that would thus accrue to scientific medicine far outweigh the arguments that may be brought against so radical a change, and, notwithstanding its highly idealistic character, in view of the present unparalleled generosity of private wealth in endowing scientific research, the present rapid and sure progress of medicine, and the intimate connection of medical advance with the interests of all classes, I look forward confidently to the future establishment of our medical schools on a basis more nearly parallel with that of the non-professional schools of the university.

What now as to the future of medical science? With the impetus which it has received from the mighty strides of the past twenty-five years, its future progress and future great achievements are assured. But it behooves us, in whose hands lies the training of the physician, to see that he enter on his work with a full realization of his responsibilities. *The future of scientific medicine lies with the university.* "Though the university may dispense with professional schools," said President Wilson in his inaugural address at Princeton a few weeks ago, "professional schools may not dispense with the university. Professional schools have nowhere their right atmosphere and association, except where they are parts of a university and

share its spirit and method. They must love learning as well as professional success, in order to have their perfect usefulness." The perfect usefulness of the professional school consists, not merely in teaching our embryo physician how to destroy bacteria, to remove tumors, or to calm the fire of fevers. These things he must understand, and these he must do daily for the suffering individual. But beyond these are larger tasks. The physician's should be a life of service and of leadership combined. He serves well when he relieves suffering; still better when he teaches men how to live; but he serves best of all when he pushes out into the unknown and makes medical science the richer for what he contributes to it. The knowledge of wise men, the deeds of diligent men and the valor of heroes are the gift of those who have preceded him. Let us see to it that he pass on this heritage, augmented, to those who follow.

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HISTORIES AND BIBLIOGRAPHIES OF PHYSICS.

The study of the science of physics, like that of any other of the expressions of activity of the human mind, may be approached from two different points of view. First, the attention may be confined to the study of phenomena and of the inductions based upon them. These inductions are seen to lead to what are called laws of physics. From the method of their establishment it is evident that these laws are but résumés of physical experience—they are classifications of phenomena according to some principle of analogy. The study of physics is usually approached in this way —a way which is open to the very serious objection that the student is very apt to think that the principles or laws with which he becomes familiar are laws in the judicial sense and not mere résumés of experience in the formation of which the mind which makes the résumé also plays a part. This must be evident to any one who considers the nature of classification and induction. There is always behind the induction, in the mind of the man who makes it, some idea or principle upon which the classification is based.

In the second place the science of physics may be studied as if it were a vital organism. We say without hesitation that this science grows and develops—expressions in which it is tacitly agreed that we are dealing with a living organism, for what grows and develops must surely have life in some form. We may then fairly put the question, 'In what does the life of science consist?' The answer to this question seems to me to be 'In the ideas and conceptions upon which the inductions and classifications of the science are based.' Examples may help to make this clear. Ptolemy explained the solar system upon one set of ideas, Copernicus on another. Sir Isaac Newton deduced the laws of optics with the help of certain conceptions of rapidly moving particles of matter. Young and Fresnel classified those same observed phenomena upon the basis of ideas of waves in an elastic medium. Faraday and Maxwell resumed the same experimental facts by conceiving them to be manifestations of electric and magnetic forces. The development in these sciences is thus seen to consist in the changes in the conceptions and ideas which lie at the basis of the classifications and inductions which lead to scientific laws. Hence if we would study science as if it were a living organism we must investigate the ideas which are back of it and which form its real life.

When studied in this latter way it will be found that the science of physics is not an isolated subject in the thought of man-

kind. For example, the discovery of America, the propounding of the Copernican system of astronomy, the invention of printing, the reformation, and the first glimmerings of observational methods of induction in the inductive sciences in the works of Paracelsus, Bruno and others of their contemporaries all appeared in the world about the same time, and may be considered to be but different manifestations of some one impulse which was acting at that time upon the composite mind of humanity. The point may be made clearer by considering the state of the European mind before these events. One of the most characteristic factors in the development of the mind of mankind during the middle ages was the gradual growth of the spirit of rationalism. As this spirit gained in influence the power of the church declined. This was due to the fact that many of the dogmas of the church, like that of exclusive salvation and infant damnation, became repulsive to reasoning men. In order to retain its hold upon mankind and prevent that worst of sins, heresy, the church had recourse to pious frauds. Miracles were invented, sanctified relics became numerous, and the church tried diligently to support its creed by imposture and falsehood. Thus a spirit of lying became prevalent and was even made systematic and raised to the dignity of a regular doctrine. This habit of continual falsehood became so powerful that the sense of truth and the love of it—both essentials of the scientific spirit—became almost extinct in the human mind. It is not, therefore, strange that science could not thrive in such an atmosphere, and that when this love of truth was revived, the reformation and the other events mentioned above followed as a necessity. This example is mentioned to illustrate what seems to be a general fact, namely, that the fundamental concepts of science at a given epoch are of the same nature as the general concepts which are characteristic of that age.

Now how is physics to be studied in this way? Evidently by a study of its history, provided, of course, that the history be of the right sort. In the light of what has been said above, it appears that a history of physics is of the right sort if it brings out clearly the life of physics, *i. e.*, if it shows what the fundamental concepts of the science at any epoch are, if it shows how those concepts change from time to time and how they grow, and if it brings out clearly the relations which exist at any epoch between the particular ideas of physics and the general ideas which are at the basis of the civilization of that epoch, and points out how those particular ideas have developed in a certain way because the more general ones have done so.

Having established this ideal of a history of physics, we may well ask whether any of the existing histories of the subject fulfill the requirements. Have any such works been written by an artist rather than by an artisan? For it has been written:* "The artist in history may be distinguished from the artisan in history; for here, as in all provinces, there are artists and artisans; men who labor mechanically in a department without eye for the whole, nor feeling that there is a whole; and men who inform and ennoble the humblest department with an idea of the whole, and who know that only in the whole is the partial to be truly discerned. The proceedings and duties of these two, in regard to history, must be altogether different. Not, indeed, that each has not a real worth, in his several degree. The simple husbandman can till his field, and, by knowledge he has gained of its soil, sow it with fit grain, though the deep rocks and central

* Carlyle, 'Essay on History,' 1830.

fires are unknown to him; his little crop hangs under and over the firmament of stars, and sails through whole untracked celestial spaces, between Aries and Libra; nevertheless it ripens for him in due season, and he gathers it safe into his barn. As a husbandman he is blameless in disregarding those higher wonders; but as a thinker, and faithful inquirer into Nature, he is wrong. So likewise is it with the historian, who examines some special aspect of history; and from this or that combination of circumstances, political, moral, economical, and the issues it has led to, infers that such and such properties belong to human society, and that the like circumstances will produce the like issue; which inference, if other trials confirm it, must be held true and practically valuable. He is wrong only, and an artisan, when he fancies that these properties, discovered or discoverable, exhaust the matter; and sees not, at every step, that it is inexhaustable.''

Having thus established the ideal by which we shall judge the histories of physics, let us see how closely the published works on the subject satisfy that ideal. We are compelled to admit at the start that there is one characteristic in the ideal history which no one has as yet attempted to embody in his work. This is the recognition of the relations between the concepts of physics and those of other subjects, *i. e.*, the writers of physical history have shown themselves to be artisans rather than artists; they have failed to perceive that there is a whole and that only in the whole is the partial to be truly discerned. It is thus evident that this discernment of the whole is beyond the present attainments of the scientific historian. Its realization is reserved for some future historian and offers to him a most enticing and remunerative field.

If then we pass over this requisite of an ideal history as being at the present time a Utopian ideal, what do we find? We shall find that there already exist several very satisfactory books upon the history of our subject. Thus some of the chapters in Whewell's 'History of the Inductive Sciences,' and especially some in his 'History of Scientific Ideas,' as the later editions of his 'Philosophy of the Inductive Sciences' are called, will be found to be very satisfactory. The best part of the work is, in my opinion, that which deals with the ancients and the middle ages. In fact, in this portion of the book he seems sometimes to move toward the realization of the first point in our ideal history—the point which we have dismissed as at present Utopian. In the later parts of the work he falls back into the much easier task of describing discoveries in their chronological order and explaining them in popular ways.

Another excellent work is that of Mach, 'Die Mechanik und ihre Entwickelung,' 1895, of which there is an English translation. This author carefully analyzes the conceptions upon which the mechanics are based, and shows how those conceptions have varied from time to time. Especially satisfactory is his chapter on the analytical mechanics in which he shows how far Newton developed the subject, using as his fundamental conception the attraction between two points. His method was purely geometrical and synthetic. He then points out how Euler and Maclaurin introduced the idea of resolving each such force into forces along three coordinate axes; and further, how finally Lagrange, by his introduction of the ideas of the calculus of variations, completed the structure. The succession of ideas here outlined is admirably treated by our author.

The historical works of Todhunter are of great value. His method is simple, direct,

and appeals strongly to a scientific mind. Thus in his 'History of the Mathematical Theories of Attraction and the Figure of the Earth,' 1873, he takes up every memoir which had been published upon that subject, analyzes it carefully, and gives his opinion as to its merit and the importance of its bearing upon the subject in hand. The same is true of his 'History of Elasticity.' It seems to me that a student could not possibly get a better grasp of these two subjects than by a careful study of these two works. Todhunter's style is rigidly scientific, being clear, exact and extremely terse.

Of the older histories of our subject those of Priestley deserve mention. This many-sided man composed, besides his theological works and his scientific works, two histories of physics: one, 'History of Electricity,' 1769; the other, a 'History of Vision, Light, and Colours,' 1792. In the preface to the latter he says it is his intention to write the histories of the other branches of the subject if the reception of the one on vision, light and colors shows that his efforts are appreciated. As the other works never appeared, it would seem that the time was not yet ripe for a history of optics. This volume contains as an appendix a list of the works which were consulted in its preparation—a rather interesting little bibliography of the subject.

There are also the treatises of Fischer, 'Geschichte der Physik,' eight volumes, 1801, and of Libes, 'Histoire philosophique des progrès de la physique,' four volumes, 1810. Both of these are rather biographical dictionaries than histories. Saverien's 'Histoire des progrès de l'esprit humain dans les sciences exactes,' 1766, should also come under this head. On the other hand, Powell's 'History of Natural Philosophy,' 1834, is a very creditable little work. In fact it deserves a far greater recognition than it has received. It has characteristics somewhat similar to the works of Whewell. There are also chapters in Montucla's 'Histoire des mathématiques,' four volumes, 1801–3, which deal with physical subjects such as mechanics and optics. However, inasmuch as its contents are largely mathematical, its discussion does not properly belong here. It is, as the German bookseller of whom I bought a copy remarked, 'ein sehr quellenreiches Werk.'

Of the more recent histories of physics Marie's, 'Histoire des sciences mathématiques et physiques,' 1883–8, is an ambitious work in twelve volumes. It consists of a series of short biographies with a list of the writings of each man and a criticism of both. It is interesting reading, for it is often well told and there are frequent anecdotes thrown in without extra charge. Caverni, 'Storia del methodo sperimentale in Italia,' five volumes, 1891, describes mainly discoveries and instruments. There are further the German works of Rosenberger, 1882; Heller, 1882; Dannemann, 1896; Hoppe, 1883; Poggendorff, 1879; Gerland, 1892, and Duhring, 1887. All of these, though marked with the careful, thorough, and plodding scholarship of the nation which produced them, are not, in my opinion, true histories in the light of the ideal which has been adopted above. The same is true of the most recent work on the subject, namely, Cajori's 'History of Physics,' 1899. In this book the entire treatment of the wonderful mental growth and the marked changes in intellectual life which marked the end of the middle ages—changes to whose operation the science of physics owes it origin—is contained in one short paragraph. The book is well written and its contents are presented in an interesting way, but it cannot be re-

garded as more than a reminder that the history of our sciences deserves attention.

There are numerous other works which contain chapters upon portions of our subject. Thus Libri, 'Histoire des sciences mathématiques en Italie,' four volumes, 1865, is very valuable. Also Pouchet's 'Histoire des sciences naturelles au moyen age,' 1855, and Cuvier's 'Histoire des sciences naturelles,' three volumes, 1831–8, contain some treatment of physics along with that of the other sciences.

From the above discussion it should be clear that an ideal history of physics, or one which approaches somewhere near to that ideal, is a much-desired and needed thing. That such a work would receive a warm welcome is evident when we note that the works of Whewell passed through three editions in ten years and have been reprinted several times since and are still carried by the Appletons among their regular books. It has also been translated into German. The work of Mach is now in its fourth German edition and has been translated into English. These are the best, in my opinion too, of the histories of science.

A satisfactory history should then be written, all the more since Whewell's work ended in 1847. The first step in the preparation of such a history seems to me to be the compiling of a bibliography. Now while astronomy has its Lalande, its Houzeau and Lancaster, its Weidler, and others, physics can boast of nothing better than Poggendorff's 'Biographisch-litterarisches Handwörterbuch zur Geschichte der exacten Wissenschaften.' This is an extremely valuable work as a reference, but it is not at all complete as a bibliography. The author expressly states that he has included in the work no one concerning whom he could find no biographical record. This being so, he has, as he himself acknowledges, omitted many books which should be in a bibliography. There are partial bibliographies, like the 'Bibliographie Neèrlandaise' of Bierens de Haan, 1883. This is a fairly complete list of the works in mathematics and physics published in Dutch during the sixteenth, seventeenth and eighteenth centuries. There are quite a number of smaller bibliographies of the works written by Italians in various towns. In fact, the Italian towns seem, now that their glory is in the past, to show a desire to exhibit their departed prowess by each town printing a list of the great works which have originated there or whose writers were born there. There are several attempts to cover certain portions of the subject which have been made by the Smithsonian Institution such as Tuckermann's 'Bibliography of the Spectroscope,' 1888. From the result it would appear either that the library in which Mr. Tuckermann worked was inadequate or that he did not spend time enough upon the subject. Kayser's 'Handbuch der Spektroscopie,' 1900, is more complete than this.

Thus a satisfactory bibliography of physics is also a much-to-be-desired thing. It does not, however, seem strange that one has not yet been compiled, for most of those who know enough physics to do the work well find that their energy is all needed to keep up with the rapid progress and expansion of their subject. But it seems now as if the time were come when such work must be done. Men are beginning to question more than ever the basis of scientific work, to look behind the principles and laws which lie on the surface, and to inquire into the real nature of the ideas upon which their science has been founded. A satisfactory answer can only be obtained through a careful study of the history of those ideas—through a knowl-

edge of the development which has taken place in bringing the concepts of science into their present form.

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UNIVERSITY REGISTRATION STATISTICS.

THE table on page 1022 furnishes an eloquent criterion of the continuous rapid development of higher education in the United States. The opening of each new academic year shows a marked advance over the last, and the number of young men and women eager to obtain a university training is keeping steady pace with the rapid growth of our country's population. It is certainly an encouraging sign to witness this growing endeavor to lead the intellectual or the scientific life, which will inevitably tend to raise the standard of American civilization and general culture.

The statistics given herewith are, with few exceptions, approximately as of November 1, 1902, and relate to the registration at eighteen of the leading universities throughout the country. It will be noticed that Syracuse University has been added this year for the first time, and the reason for this is self-explanatory. The figures have been obtained from the proper officials of the various institutions concerned, and are as accurate as statistics of this nature can be made. A number of changes may occur during the year, but they will not be of such a serious nature as to affect the general result. The question of proper enrolment figures is assuming greater importance each year, and it goes without saying that there is a tendency to attain as much uniformity as possible in the methods employed at the various universities. At the annual meeting of the Association of American Universities, to be held under the auspices of Columbia University in New York city on December 29, 30 and 31, 1902, a representative of Columbia will present a paper on the subject of 'Uniformity of University Statistics' which should bring out some interesting facts relating to this matter. The question of double registration, for example, presents more than one perplexing problem, and a number of universities are endeavoring to eliminate enrolment in two faculties from their figures altogether by simply taking into consideration the primary registration. One great obstacle in the path of this desire is the number of summer session students who return for work in the fall, of which there were this year 291 at Cornell, 139 at Harvard, 210 at Columbia, and so forth. These students were not registered in two faculties, and yet they caused duplication. In the case of several universities this was lost sight of altogether in last year's compilation, and the apparent falling off in the total enrolment of Harvard, Michigan, and Cornell is due to this circumstance. On the whole, there has been a noticeable increase shown in the summer session enrolment throughout the country, and this particular feature of university work seems to be meeting with popular favor.

Last year the relative rank of the seventeen leading universities on the basis of total enrolment was as follows: Harvard, Columbia, Michigan, Chicago, California, Minnesota, Cornell, Wisconsin, Yale, Pennsylvania, Northwestern, Indiana, Nebraska, Missouri, Princeton, Leland Stanford, Johns Hopkins.

If we count in the students attending courses for teachers, who are held to the full requirements of regular courses in Teachers College, it will be seen that Columbia has passed the 5,000 mark and has almost reached Harvard. Chicago has had a considerable increase over last year, has

	California.	Chicago.	Columbia.	Cornell.	Harvard.	Indiana.	Johns Hopkins.	Leland Stanford, Jr.	Michigan.	Minnesota.	Missouri.	Nebraska.	Northwestern.	Pennsylvania.	Princeton.	Syracuse.	Wisconsin.	Yale.
College Arts, Men		613	484	783	2,107	609	162		662	491	318	407	323	471	758	491	681	1,205
College Arts, Women	2,315	829	342		414	453	...	1,249	607	688	216	546	363		...	390	481	...
Scientific Schools.*		...	682	1,181	583	...	...		597	496	224	551	...	432	494	172	573	760
Law	80	59	463	222	636	90	...	§	847	430	108	166	171	340	...	134	219	290
Medicine	131	222	773	385	445	...	259	...	417	285	91	152	605	469	...	139	...	142
Agriculture	†	...	...	106	28	...	...	...	...	460	72	118	...	...	...	...	456	...
Art	150	...	...	...	...	...	...	...	...	...	...	66	102	...	...	45	...	60
Dentistry	126	...	...	...	112	...	...	...	151	145	...	...	615	403	...	...	...	...
Divinity	...	198	...	...	37	...	...	...	...	...	...	...	152	...	...	...	...	112
Forestry	...	...	...	68	...	...	...	...	...	...	...	...	...	...	...	...	...	38
Music	...	...	...	...	...	...	...	...	...	...	...	302	357	...	...	565	182	100
Pharmacy	77	...	...	...	...	...	...	...	68	60	...	...	206	...	...	...	31	...
Teachers College	‡	95	563	...	...	...	...	...	...	...	...	...	...	...	...	‡	...	...
Veterinary	...	...	...	62	...	...	...	...	...	...	...	...	...	61	...	...	...	...
Graduate Schools	172	427	513	188	314	61	179	81	79	160	‖	108	46	187	93	45	102	350
Courses for Teachers	...	...	1,196	...	...	...	...	...	...	...	...	...	...	196	...	...	...	...
Summer Session	830	2,350	643	548	945	569	...	48	454	320	468	256	...	...	...	39	339	...
Other Courses	45	...	23	56	...	...	70	...	73	...	...	...	...	...	...	100	...	19
Deduct Double Reg.	[250]	[497]	[330]	[318]	[153]	[134]	[1]	...	[191]	[30]	[89]	[383]	[65]	[10]	...	[100]	[180]	[272]
Grand Total	3,676	4,296	5,352	3,281	5,468	1,648	669	1,378	3,764	3,505	1,408	2,289	2,875	2,549	1,345	2,020	2,884	2,804
Teaching Staff	308	196	504	421	533	65	147	129	255	280	92	173	285	279	101	170	188	307

* Includes Schools of Engineering, Chemistry, Architecture, Mines, and Mechanic Arts.

† Included in Scientific Schools.

‡ Included in college statistics.

§ Included in college statistics. 178 law students are enrolled.

‖ Included in college and scientific school statistics. About 53 graduate students are enrolled.

passed Michigan and now ranks third, or if Columbia's extension students be deducted, second, with Columbia third. Michigan occupies fourth place, and then come California, Minnesota, Cornell and Wisconsin in the same relative positions as last year. Northwestern's increase of over 400 has placed her ahead of both Yale and Pennsylvania, which occupy tenth and eleventh places, respectively. Nebraska has passed Indiana, likewise showing an increase of almost 400. Syracuse also has a larger enrolment than Indiana. After Indiana and Missouri comes Leland Stanford, which has passed Princeton.

As far as the different departments are concerned, it will be seen that Harvard still shows by far the largest collegiate enrolment. On the whole there has been a small increase in the total number of college students attending the universities under consideration. The scientific schools show a large general increase all along the line, with the single exception of Missouri. There are fewer law students than there were in 1901, in spite of the fact that Chicago has added a law faculty since last year. The total number of medical students also shows a decrease, which is accounted for largely by the facts that the admission requirements at Columbia have been strengthened, and that the last class admitted at Harvard without the degree requirements graduated in the spring. Michigan has still the largest enrolment in its law faculty, and Columbia still heads the list in the faculty of medicine and in the graduate schools. The grand total of graduate students shows a slight increase over that of last year. There have been no important changes in the relative ranking of the teaching force in the largest institutions, Harvard still leading, with Columbia second. RUDOLF TOMBO, JR.,

COLUMBIA UNIVERSITY. *Registrar.*

NEW DEPARTURES IN THE BIBLIOGRAPHICAL WORK OF THE CONCILIUM BIBLIOGRAPHICUM.

SINCE an article published in the *American Naturalist* in 1898 no adequate account of the work of the Concilium Bibliographicum has appeared in the scientific press. SCIENCE has regularly reprinted extracts from the 'Annual Statements' of the Concilium, but these notices have necessarily been somewhat disconnected and have not emphasized certain features of the work insufficiently appreciated in America.

The bibliographical references gathered by the Concilium may, for practical purposes, be divided into two great categories, the manuscript cards and the printed cards. The references contained in the former are far more numerous than those recorded in the latter, and in general the bibliography in manuscript form is a very essential part of our task. Although open to subscription, this bibliography is quite unknown in America, not even a sample card ever having been asked for. In regard to the printed bibliography the state of affairs is somewhat better, but our work is, nevertheless, insufficiently understood, as a consultation of our subscription list must show.

The printed card catalogue is supplied according to two entirely different arrangements, each of which has its utility—the alphabetical authors' catalogue and the methodical arrangement, embracing as chief subdivisions: paleontology, general biology, microscopy, zoology, anatomy and physiology. To have an ideally complete bibliography, an institution should have these two arrangements complete.

Such subscriptions have been received from European institutions; none ever reached us from America. The nearest approach to this condition is to be found in the University of Minnesota, where two

subscriptions complete each other, so that everything is present save the authors' catalogue in anatomy and physiology. The same may be said of Harvard University, if we take the Cambridge and Boston departments together. Disregarding the authors' catalogue, a complete methodical arrangement is to be found in Cornell University, in Columbia University, in the City Library in Springfield, Mass., in the State Library in Albany and (excepting physiology) in the John Crerar Library, Chicago. Leaving out of account anatomy and physiology, the complete methodical set of cards is to be found, furthermore, in the University of Michigan, the University of Kansas, the University of Nebraska, the University of Wisconsin, Carleton College and Princeton University. As the above statement shows, there are great scientific centers, including, for example, all points west of Lincoln, Nebr., and south of Princeton, N. J., where our work is not accessible in such form that we should be willing for it to be taken as a test. This point we desire to emphasize, for we have reason to believe that, in every case where our bibliography has proved inefficient, it has been solely due to a complete misconception of the possibilities really offered. Only such persons as have access to the above-mentioned sets of cards will be able to verify the following account.*

I. THE PRINTED CARD CATALOGUE.

In reviewing the progress of the work since 1898, the most salient feature is the far greater completeness of the record. Perfection has not of course yet been attained in this respect; but, since a complete register is kept of every fascicule excerpted, we know precisely where every gap occurs and it will eventually be filled. In any event, our bibliography for zoology is probably to-day more complete than any other in existence. The number of entries in the methodical set of cards already exceeds 92,690, and the individual cards published 11,000,000.

The arrangement of the complete methodical set is such that there is scarcely any limit to its possibilities in matter supplying bibliographical information. That one can at once ascertain the works having as their object a given genus, or a given group of animals, is of course evident. With equal facility, the bibliography of such questions as viviparity, regeneration, flight, spermatogenesis, gastrulation, mechanics of development, structure of the vascular system, songs and cries, hibernation, centrosome, recent and fossil fauna of Kansas, studies on Miocene mammals, etc.

Such groupings existed already in 1898; but since that time a change has taken place in the entries, which constitutes a veritable revolution in bibliographical methods and affords a precision which even those intimately connected with the work at first thought unattainable.

Let us compare the procedure at present followed in the Concilium with the admirable bibliography in the *Zoologischer Anzeiger,* which certainly represents the greatest perfection heretofore attained.

I have taken the pains to look up the entries in the *Anzeiger* recorded under fauna of Rhode Island from 1896 to 1901, and find a single reference to a paper by Eaton on the 'Prehistoric Fauna of Block Island'; Hollick's 'Notes on Block Island' and G. W. Field's 'Plankton Studies' hav-

* At present all the topical cards issued prior to 1898 are out of print. Two sets tolerably complete from the middle of 1898 on are still on hand. When these have been disposed of, nothing will remain of the issues prior to 1899, which itself is nearing exhaustion. Finally, a single copy of the authors' catalogue can still be had complete from 1896. Save for this one set, the authors' catalogue is already entirely out of print up to January, 1902.

ing been apparently overlooked. Had the Concilium followed the usual methods of bibliography, there would have been only the advantage of greater completeness and the ease of reference resulting from the use of the card system. The long search would have been replaced by a single glance; that is all. But it is evident that a bibliography of the fauna of Rhode Island must contain references to such works as Carpenter's studies on the 'Shell-bearing Mollusca of Rhode Island.' Hitherto such references had, however, always been simply classed under Mollusca. In 1897, however, the Concilium attempted the innovation of entering such papers also under the appropriate faunistic heading, and so laid the basis for its so-called 'complete series,' which to-day forms the principal *raison d'être* of the bibliography.

Towards the end of 1897 a further step was taken in classifying according to the text and not according to the title. Thus Ehrmann's 'Notes on Eastern North American Cychrus' was classified under Rhode Island, because the text showed that his collections came from that state.

Then in 1899 a very important step was taken, which had at first seemed quite impossible. This was the introduction of multiple exhaustive entries. Till then papers of so general a character that they embraced species from all the various continents were omitted from the special faunistic bibliography. From 1899 on, however, it has been attempted to take account of every feature of the publication to be recorded. Thus a paper on tropical Coleoptera, if it contained references to African, South American and Malayan forms would be classified under Coleoptera, under Africa, under South America and under Malayan Archipelago. If, in addition, there were a section devoted to mimicry and another to myrmecophily, two further editions of the card reference would be issued classed under these headings. Thus, for example, in Kerremans' third study on Buprestidæ, 96 new species were described, of which one solitary species of *Brachys* came from Florida. Subscribers will find the entry in the appropriate place under fauna of Florida.

This new procedure brought the bibliography to a state of perfection that certainly never was attempted before; but there still remained one difficulty, which, in spite of many experiments, we were unable to overcome until the present year.

The subscriber who desires to receive all references to the fauna of Rhode Island can not depend upon finding all he requires in our division Fauna of Rhode Island, even though our treatment of the section has been so exhaustive. There are papers on the Fauna of New England in general that contain notes on Rhode Island.* There may be important observations on Rhode Island in papers that we have been forced to classify under fauna of the United States or even of North America in general.

In order to obviate this difficulty our bibliographers now, in reading a paper, jot down each item as they come to it; thus, if they find species from Ontario, from all of the New England States, from New Mexico and from California, they will have recorded every single state; if the paper have notes on the structure of the eyes, the heart, and the kidneys, this will have been recorded; finally, if the paper be on Mollusca of the families Unionidæ, Helicidæ and Cyclostomidæ, evidence of this will be found in the notes taken. Three editions only of the card will be issued under anatomy, North American fauna and Mollusca; but the edition appearing in the division anatomy will have

* Thus King's 'Further Notes on New England Formicidæ' deals with Vermont, Massachusetts and Rhode Island forms.

subsidiary symbols stating that only the eyes, the heart and the kidney are treated, that classed under Fauna of North America will enumerate all the states concerned, while finally the card intended for entry under Mollusca will state that Lamellibranchs, Prosobranchs and Pulmonates are included.

Such a card would have the following appearance:

Doe, John. 4 (7)

1902. New Land and Fresh-water Molluscs, with Notes on Anatomy. Proc. Townville Nat. Hist. Soc., Vol. 4, p. 3–24, 3 figs. [6 nn. spp. in Roeina n. g. 2, Helix 4]

4.1,.32,.38 (71.3, 74.1–.6, 78.9, 79.4)

Such notices are given in terms of the decimal classification. Thus the main card would appear under 4 Mollusca, and at the end of the text the sorters would find in inconspicuous type the instructions 4.1 (Lamellibranchs), 4.32 (Prosobranchs) and 4.38 (Pulmonates), or, as it is abbreviated, 4.1,.32,.38. These check numbers are of course useful to any subscriber who has taken the pains to study our system of classification, but the main purpose is to guide the sorters in dividing up the cards classified under general headings. Each subscriber then to the fauna of Rhode Island would receive notices of papers treating Rhode Island quite incidentally.

Since 1899 record has been kept of every new species, etc., even though thirty or more lines of print may have been necessary to give the citation. Repeatedly an entire day has been devoted to excerpting a single monograph. In regard to this, however, we can be more explicit in the second part of this communication.

Before terminating this first article attention should be frankly drawn to the defective state of our anatomical and physiological bibliographies. Financial difficulties have here alone stood in the way; each year we have hoped to be able to make these two sections worthy of the undertaking; but as often have we been obliged to postpone such action. Practical reasons make it wiser to apply the most approved methods to the excerpting of the zoological articles rather than to ever do this work in a less perfect manner. Delay in publishing the anatomical and physiological parts can eventually be made good. Hasty, incomplete work in reading and classifying a zoological memoir leaves no outwardly visible trace, but is a lasting blemish.

The Concilium has a right to expect from America subsidies, similar to those offered to it in Europe. It never can be self-supporting without raising its prices, so as to place it at the service of the privileged few instead of being open to all. Nevertheless, the present state of its subscription list can only be explained by an extraordinary ignorance of the facilities offered. Is it possible that there is not a person in Rhode Island, not a library, not a laboratory, willing to purchase (for ten cents) the bibliography of the fauna of this state during seven years? I should have supposed there would be fifty in Providence alone. We have separate special bibliographies for each state in the Union. Not one of them has yet found a subscriber! For completeness we must continue them, no matter how great the loss. And so it is with every other department. Personally I can scarcely conceive that there is a serious worker in zoology who would not find it to his advantage to enter into relations with the Concilium. The institution has solved the bibliographical problems that stood before it in a most satisfactory fashion. All that remains is for workers the world over,

and especially in America, where the enterprise had its origin, to obtain full profit from its work. If there be any difficulties in the way we should be glad to know of them. It would be of the greatest service to us for us to be informed of any bibliographical need which we can not fill. The system is so elastic that past experience warrants us in saying that no legitimate demand that can be made on a bibliography need remain unfilled.

SOCIETIES AND ACADEMIES.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE fifty-second annual meeting of the American Association for the Advancement of Science, and the first of the Convocation Week meetings, will be held in Washington, D. C., December 27, 1902, to January 3, 1903. The retiring president is Professor Asaph Hall, U.S.N., and the president elect, President Ira Remsen, Johns Hopkins University. The permanent secretary is Dr. L. O. Howard, Cosmos Club, Washington, D. C., and the local secretary, Dr. Marcus Benjamin, Columbian University, Washington, D. C. President Roosevelt is honorary president of the local committee. The preliminary program with information in regard to hotel headquarters, railway rates, etc., will be found in the issue of SCIENCE for November 21. The following scientific societies will meet at Washington in affiliation with the Association:

The American Anthropological Association will hold its first regular meeting during Convocation Week in affiliation with Section H of the A. A. A. S. President, W J McGee; secretary George A. Dorsey, Field Columbian Museum, Chicago, Ill.

The American Chemical Society will meet on December 29 and 30. President, Ira Remsen; secretary, A. C. Hale, 352A Hancock street, Brooklyn, N. Y.

The American Folk-lore Society will meet in affiliation with Section H of the A. A. A. S. President, George A. Dorsey; vice-presidents, J. Walter Fewkes, James Mooney; secretary, W. W. Newell, Cambridge, Mass.

The American Microscopical Society will hold a meeting on January 1. President, E. A. Birge, Madison, Wis.; secretary, H. B. Ward, University of Nebraska, Lincoln Nebr.

The American Morphological Society will meet on December 30 and 31. President, H. C. Bumpus; vice-president, G. H. Parker; secretary and treasurer, M. M. Metcalf, Woman's College, Baltimore, Md.

The American Philosophical Association will meet on December 30 and 31 and January 1. Secretary, H. N. Gardiner, Northampton, Mass.

The American Physical Society will meet in affiliation with Section B of the A. A. A. S. President, Albert A. Michelson; secretary, Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Physiological Society will meet on December 30 and 31. President, R. H. Chittenden; secretary, F. S. Lee, Columbia University, New York, N. Y.

The American Psychological Association will meet on December 30 and 31 and January 1. President, E. A. Sanford; secretary and treasurer, Livingston Farrand, Columbia University, New York, N. Y.

The American Society of Naturalists will meet on December 30 and 31. President, J. McK. Cattell; vice-presidents, C. D. Walcott, L. O. Howard, D. P. Penhallow; secretary, R. G. Harrison, Johns Hopkins University, Baltimore, Md.

The Association of American Anatomists will meet on December 30 and 31. President, G. S. Huntington; vice-president, D. S. Lamb; secretary and treasurer, G. Carl Huber, University of Michigan, Ann Arbor, Mich.

The Association of Economic Entomologists will meet on December 26 and 27. President, E. P. Felt; secretary, A. L. Quaintance, College Park, Md.

The Astronomical and Astrophysical Society of America will meet during Convocation Week, in affiliation with Section A of the A. A. A. S. President, Simon Newcomb; secretary, George C. Comstock, University of Wisconsin, Madison, Wis.

The Botanical Society of America will meet on December 31 and January 1. President, B. T. Galloway; secretary, D. T. MacDougal, New York City.

The Botanists of the Central and Western States will meet on December 30. Committee in charge of the meeting, John M. Coulter, University of Chicago; D. M. Mottier, University of Indiana, Bloomington, Ind.; Conway MacMillan, University of Minnesota, Minneapolis, Minn.

The Geological Society of America will meet on December 29, 30 and 31. President, N. H. Win-

chell; vice-presidents, S. F. Emmons, J. C. Branner; secretary, H. L. Fairchild, University of Rochester, Rochester, N. Y.

The National Geographic Society will hold a meeting during Convocation Week. President, A. Graham Bell; vice-president, W J McGee; secretary, A. J. Henry, U. S. Weather Bureau, Washington, D. C.

The Naturalists of the Central States will meet on December 30 and 31. Chairman, S. A. Forbes; secretary, C. B. Davenport, University of Chicago, Chicago, Ill.

The Society of American Bacteriologists will meet on December 30 and 31. President, H. W. Conn; vice-president, James Carroll; secretary, E. O. Jordan, University of Chicago, Chicago, Ill.; council, W. H. Welch, Theobald Smith, H. L. Russell, Chester, Pa.

The Society for Plant Morphology and Physiology will meet during Convocation Week. President, V. M. Spalding; vice-president, B. D. Halsted; secretary and treasurer, W. F. Ganong, Smith College, Northampton, Mass.

The Society for the Promotion of Agricultural Science will meet during Convocation Week. President, W. H. Jordan; secretary, F. M. Webster, Urbana, Ill.

The Zoologists of the Central and Western States will meet during Convocation Week. President, C. B. Davenport, University of Chicago.

GEOLOGICAL SOCIETY OF WASHINGTON.

At the 133d meeting held November 26, 1902, the following papers were presented:

'Some Facts and Theories Bearing on the Accumulation of Petroleum,' by C. W. Hayes. Mr. Hayes pointed out the great diversity in conditions under which petroleum has accumulated in different regions and that conclusions drawn from a study of the Appalachian field are not applicable to the Texas-Louisiana field. The physiography, stratigraphy and structure of the Gulf coastal plain were briefly outlined and the peculiar quaquaversal structure of the Spindletop oil pool was described. Spindletop is regarded as the type of a geologic structure occurring at numerous points in southwestern Louisiana and southeastern Texas. Among the localities at which the same or a similar structure has been detected are the five 'salt islands' of Louisiana, Hackberry Island, Damon Mound, Big Hill and High Island. All of these and others at which sufficient drilling has been done to afford information concerning their structure are found to be quaquaversals. Further, all are composed of essentially the same material, viz: (1) Surface clays and sands, (2) limestone (with clay and sand) in part dolomitic and cavernous and containing native sulphur and petroleum, (3) gypsum, (4) rock salt. The thickness of the salt has in no case been determined, although one drilling penetrated it to a depth of 2,100 feet.

The theory for the explanation of these phenomena was first proposed by Robt. T. Hill. It is that along lines of structural weakness, extending across the Gulf coastal plain in a northeast-southwest direction parallel to the well-known Balcones Fault of central Texas, that saline waters ascended from great depths bringing up the petroleum which is widely disseminated through the coastal plain formations and also depositing the salt and gypsum. In some cases these springs were sealed over by later sedimentary deposits retaining the oil and in others the oil escaped. Some of the difficulties in the way of the theory were pointed out and the conclusion stated that, while suggestive and worthy of careful consideration, the theory can not be accepted in its present form.

'Mountain Growths of the Great Plains,' by Mr. Bailey Willis. Mr. Willis called attention to three local mountain growths lying within the otherwise little-disturbed area of the Great Plains between the Mississippi and the Rocky Mountains, viz., the St. Francis Mountains, Missouri, the Wichita Mountains, Oklahoma, and the Black Hills, South Dakota. Each of these groups of hills represents an eroded uplift less than 100 miles in maximum diameter, of an approximately oval form. The central massif in each case consists, at least in great part, of pre-Cambrian igneous rocks. The uplift of the St. Francis Mountains occurred during late Cambrian time; that of the Wichitas during the late Carboniferous; and that of the Black Hills in the early Tertiary. Undisturbed Cambro-Silurian strata still surround the bases of the St. Francis Mountains, and the Wichitas are

similarly being uncovered of the Red Beds, which are there probably Permian. These two groups thus represent very ancient hills, preserved to us through burial, and exhibiting, as they are now uncovered, topographic features of Cambrian and Carboniferous dates, respectively. Although Silurian and earlier strata surrounding the Wichitas are folded and overthrust, and although there are some evidences of compression in the strata dipping away from the Black Hills, the elevation in these cases, as in that of the St. Francis Mountains, is apparently due rather to vertical than to horizontal stress. Each of the domes appears to stand for the local effect of a vertical movement, such as that which in the Appalachian province has raised the Cretaceous peneplain to the height of the Appalachian Mountains; and the internal structures may be discriminated as effects of earlier deformation. The comparison of the three uplifts brings out the fact that similar effects of vertical movement have been produced at intervals from Cambrian to Tertiary; and the nature of the growths bears interestingly on the problem of the cause of such local upward swelling.

'Stratigraphic Relations of the Red Beds to the Carboniferous and Permian in Northern Texas,' by Geo. I. Adams. This paper reported the results of a reconnaissance made for the purpose of reviewing the mapping done by Mr. Cummins of the Texas Survey. It was found that the limestones of the Albany division, although they thin out northward, extend across the line drawn as the contact between the Carboniferous and the Permian, and are represented in the Clear Fork and Wichita divisions. The approximate limit of the red color is a line diagonal to the strike of the formations and is found to correspond in a general way with the line drawn by Mr. Cummins as separating the Carboniferous and Permian. The vertebrate fossils from the Clear Fork and Wichita divisions which have been referred to Permian, are now known to belong to the Albany which was classed as Carboniferous by the Texas Survey.

'Volcanic Dust from Guatemala,' by J. S. Diller. Mr. J. S. Diller presented specimens of volcanic sand and dust received through the U. S. Weather Bureau and the Chamber of Commerce, San Diego, Cal., from the recent eruption of Santa Maria in Guatemala. The dust is remarkable for its light color and feldspathic character. Ferromagnesian silicates are subordinate and the glass particles are very clear, as in dusts from volcanoes erupting trachytes or rhyolites.

One sample collected October 25 on the deck of the steamer *Luxor* while in the harbor of San Benito, Mexico, sixty miles from the volcano, is uniformly fine sand with particles nearly a millimeter in diameter. The particles are chiefly feldspar, of which only a small part show distinct lamellar twinning. The mineral grains are generally coated with clear vesicular glass.

The other sample collected on the deck of the same vessel October 26, 200 miles from the volcano, is much finer, like flour, and composed predominantly of glass particles ranging about .15 mm. in diameter. A chemical examination of the coarser material will soon be made.

ALFRED H. BROOKS,
Secretary.

AMERICAN CHEMICAL SOCIETY, NORTHEASTERN SECTION.

THE regular meeting of the Northeastern Section of the American Chemical Society was held Saturday, November 29, at Room 22 Walker Building, Massachusetts Institute of Technology.

Mr. Francis Fitz Gerald, of the International Graphite Company of Niagara Falls, addressed the society on 'The Acheson Furnace and its Products,' describing the processes and apparatus used by the company in the manufacture of carborundum and graphite.

The following officers for the ensuing year were elected:

President, Augustus H. Gill.
Vice-President, Henry Howard.
Secretary, Arthur M. Comey.
Treasurer, B. F. Davenport.
Executive Committee, R. P. Williams, G. P. Baxter, B. S. Merigold, H. C. Lythgoe, Henry Fay.

Members of the Council, H. P. Talbot, L. P. Kinnicutt, C. L. Parsons.

ARTHUR M. COMEY,
Secretary.

THE NEW ENGLAND ASSOCIATION OF CHEMISTRY TEACHERS.

THE Association held its fifteenth regular —sixth annual—meeting Saturday, November 15, at the Dorchester High School, Boston. The Association holds three regular meetings per year, its membership being drawn from all sections of the United States, but mostly from New England. Visits were made in the forenoon to the New England Gas and Coke Plant and the United States Steel Works at Everett. The principal paper of the afternoon was by Professor Arthur A. Noyes, of the Massachusetts Institute of Technology, on 'The Interpretation of the Usual Scheme of Qualitative Analysis Through the Mass Action Law and the Ionic Theory,' accompanied by experiments. The following officers were elected for the ensuing year:

President, L. G. Smith, Roxbury.

Vice-President, A. S. Perkins, Dorchester.

Secretary, George A. Cowen, West Roxbury.

Treasurer, E. F. Holden, Charlestown.

Executive Committee, George W. Earle, Somerville; Miss Laura P. Patten, Medford; Oliver P. Watts, Waltham.

COLUMBIA UNIVERSITY GEOLOGICAL JOURNAL CLUB.

December 5.—The following papers were reviewed: T. Nelson Dale, 'Bulletin 195 U. S. G. S.,' by Mr. Fred H. Moffit. Mr. Moffit has been Professor Dale's assistant for the past five years and gave much additional information concerning Vermont geology with some interesting problems of which this Bulletin deals. Rudolf Dekeskamp, on the 'Distribution of *Barium* in Rocks and Mineral Springs as Bearing Especially upon the Theory of Lateral Secretion' (*Zeitschrift für Praktische Geologie,* April, 1902), by Professor J. F. Kemp. H. W. SHIMER.

BOSTON SOCIETY OF NATURAL HISTORY.

THE first meeting of the season was held on November 5, 1902. Dr. T. A. Jaggar, Jr., spoke on the 'Possibility of Volcano-Proof Construction.' During the past summer the speaker had investigated the destructive work of Mt. Pelée in the Antilles and described the eruptions there as of a common type in which there are tremendous explosions of steam, hot dust, and stones, but with no good evidence of lava flows. The loss of life is chiefly by the intense heat, by falling of solid bodies, such as stones, by blasts of wind, and by suffocation from causes not clearly defined, but perhaps in some cases by gases. The few survivors of the explosions on Martinique and St. Vincent were in each case sheltered in very tightly constructed rooms which admitted but little outside air, and were protected in some measure by large walls of masonry on the side towards the volcano. A number of lantern slides were shown illustrating the effects of the explosions.

The second paper was by Dr. W. E. Castle, on 'Mendel's Principles of Heredity.' Mendel's work on hybridization was performed about fifty years ago, but until recently his discoveries have gone almost unnoticed. Among the more important of Mendel's discoveries are: (1) The law of dominance, when, for example, the offspring of two parents differing in respect of one character, all resemble one parent, and possess, therefore, the dominant character, that of the other parent being latent or recessive. (2) In place of simple dominance, there may be manifest in the immediate hybrid offspring an intensification of character, or a condition intermediate between the two parents, or the offspring may have a peculiar character of their own. (3) A segregation of characters united in the hybrid takes place in their offspring, so that a certain per cent. of these offspring possess the dominant character alone, a certain per cent. the recessive character alone, while a certain per cent. are again hybrid in nature.

At the meeting of November 19, 1902, Mr. William Lyman Underwood spoke on 'Bird Photography.' A large number of lantern slides of New England birds was shown, most of which were obtained after much painstaking work in northern Maine. Mr. Underwood's observations showed that, in the case of the chickadee and the yellow-bellied sap-

sucker, the male parent alone attends to the cleaning of the nest while it is in use by the fledglings. The methods used in securing the photographs, as well as the manipulation of the cameras, were explained by the speaker.

GLOVER M. ALLEN,
Secretary.

DISCUSSION AND CORRESPONDENCE.

THE STRATIGRAPHIC POSITION OF THE JUDITH RIVER BEDS. A CORRECTION OF MR. HATCHER'S CORRECTION.

IN SCIENCE of November 21 Mr. J. B. Hatcher publishes a note in which he disputes some statements made by Professor Osborn in an article on 'New Vertebrates of the Mid-Cretaceous.' One of these relates to the position of the Judith River Beds, and Mr. Hatcher expresses the opinion that these beds which have usually been considered part of the Laramie are really much older than that formation. He says that 'The fact that Cretaceous Nos. 2 and 3 [Benton and Niobrara] are entirely wanting in this region leads to the inference that they are represented by the lower members of the Judith River beds, and that the lower members of these beds are in reality older than the oldest of the Belly River series, a little farther north.' This inference is wholly incorrect, but as it claims to be based on the field observations of so able and careful a worker as Mr. Hatcher it is likely to be accepted by many and to confuse all future discussions of the subject if it is not promptly corrected.

It has long been known that the equivalents of the Fort Pierre and Fox Hills beds underlie the Judith River beds in their typical exposures near the mouth of Judith River. Mr. Hatcher quotes Meek and Hayden's erroneous statement of 1857, but if he had examined their later references to the geology of the region he would have found the error corrected and that the sandstone first called 'No. 1' was later referred to the Fox Hills or 'No. 5.'*

The section has been studied by E. D. Cope, C. A. White and doubtless many others. In 1894 it was the writer's privilege, in company with Mr. W. H. Weed, to examine the section along the Missouri River from Fort Benton to the mouth of the Judith. Between these two points the distance along the meandering course of the river is somewhat over 100 miles and the rocks are well exposed almost continuously from the Benton shales up to the Judith River beds. By the latter term I mean the brackish- and fresh-water beds to which it was first applied, well exposed on both sides of the Missouri River near the mouth of Judith River, Montana. At many places in this neighborhood these beds were seen to lie directly on shales and sandstones containing an abundant marine invertebrate fauna which elsewhere is known to be characteristic of the Fox Hills beds. The relation of these fossiliferous marine beds to the overlying Judith River beds may be seen near the mouth of Dog Creek about three miles east of Judith P. O.; on Dog Creek three to four miles above its mouth; on the north side of the Missouri opposite Judith; and on the north side of the Missouri three miles northwest of Judith. Among the species collected are *Cardium speciosum* M. & H., *Mactra alta* M. & H., *Avicula nebrascana* M. & H., *Cymella undata* M. & H., *Sphæriola cordata* M. & H., *Callista nebrascensis* M. & H., and *Tancredia americana* M. & H. These are sufficient to establish the horizon as Fox Hills without question and the overlying Judith River beds cannot possibly be very much older than the Laramie. In my opinion they *are* Laramie.

The marine beds containing the faunas of the Fox Hills and Fort Pierre are exposed along the Missouri River for some miles above the mouth of the Judith. Between these and the typical Benton shales there is a series of coal-bearing sandstones and shales whose stratigraphic position is precisely the same as that to which the Belly River series has been assigned. In the Fort Benton folio Mr. Weed has called this the Eagle formation. It is separated from the Judith River beds by several hundred feet of marine beds and the lithologic resemblance is not very close, though it might be possible to confuse them in areas where the section is not well exposed.

* See Meek's statement in U. S. Geol. Surv. Terr. quarto Vol. IX., 1876, pp. xxxvi, xlviii, xlix.

It is just possible that in the Canadian areas that have been referred to the Belly River beds two or more distinct horizons have been confused under one name. In fact the late Dr. George M. Dawson admits this possibility in one of his early descriptions* of the Belly River beds, stating that in certain areas the beds assigned to the Belly River might be supposed to *overlie* the Pierre shales rather than underlie them. His descriptions and the invertebrate fossils that he reports arouse the suspicion that at some localities the formation includes the Fox Hills and the Judith River beds.

Whether the subsequent work of the Canadian geologists has removed all grounds for doubt as to the stratigraphy in all the Belly River areas and whether these doubts could reasonably involve any of the localities at which vertebrate remains were obtained I have not been able to learn from the published reports. These queries are worthy of the attention of those familiar with the field.

The point which I wish to emphasize is the truth of Professor Osborn's statement that 'the true Judith River beds certainly overlie the Fort Pierre and are of more recent age.'

T. W. Stanton.

Washington, D. C.,
November 25, 1902.

* Geol. Surv. Canada, 'Rept. of Progress for 1882–83–84,' pp. 118–126 C.

THE PRICKLES OF XANTHOXYLUM.

In No. 413 of Science, p. 871, there appeared a note calling attention to an error which occurs in some books regarding the nature of the prickles of *Xanthoxylum*. As in that note also the 'Cyclopedia of American Horticulture' is cited as making the erroneous statement that the paired prickles at the base of the petioles are stipular spines, I should like to point out that this statement is made only in the illustration, while in the text these bodies are always called prickles, though no particular mention is made of the occasional occurrence of paired prickles at the base of the petioles, and none of the absence of stipules in the genus, since this is a character common to the whole family of Rutaceae. The discrepancy of text and illustration is explained by the fact that the illustration was inserted without my knowledge after I had sent in my manuscript and that I had no opportunity to read proofs of my articles in the fourth volume of that work, since I was abroad in Europe during the time it was printed. If I had considered the prickles in *Xanthoxylum* metamorphosed stipules, I certainly should have spoken of them as spines and not as prickles. There occurs a similar arrangement of prickles in some species of roses, chiefly in species of the sections Cinnamomeæ and Carolinæ, but in this case no doubt can arise of their nature, since the true stipules are conspicuously present, usually adnate to the petioles. In both genera these prickly bodies are simply outgrowths of the epidermis and, therefore, morphologically to be considered prickles, though they might, in regard to their ecological significance, possibly be considered equivalent to stipular spines.

Alfred Rehder.

Arnold Arboretum.

NATURAL HISTORY IN ENGLAND.

In a letter to the editor of Science, December 5, 1902, Professor Packard writes as follows:

"Our American children are * * * woefully lacking in interest in natural history * * * far behind German, and even English children, I fancy."

The 'even' in this sentence staggered me so completely that I am moved to write in protest—or at least in inquiry. I received my school education—the regular English classical course—in Sussex and Worcestershire, and spent various holidays in Devonshire. I thus had groups of boy friends and acquaintances in three English counties. So far as I remember, it was a matter of course that we should be interested in some branch of natural history. At any rate, I can now recall but two exceptions to this rule from the whole list of my schooltime friends. And I well remember that our natural history interests proved a bond of friendship with farmers' boys and gamekeepers' sons, with whom we should otherwise, as public-school boys, have been at daggers drawn.

I know practically nothing at first-hand of German school-boys. But I am sure that the natural history interest was more general in my time at Oxford than it was among the German students I met at Leipzig. On German walking tours I have often been astonished at the ignorance of natural objects shown by my German companions; while my experience in England has always been that some one in the party knew the birds, some one the insects, some one the plants, some one the fossils—and that the rest were thirsty for information.

So I have been accustomed to regard an interest in natural history as the birthright of the English child. If this is mere insular prejudice, I must give it up; if it has the basis in fact that I think it has, I hope that Professor Packard will retract his 'even.' We owe a great deal to Germany; but—natural history!

On the general subject of nature study I may, perhaps, be allowed to say that—so far as I have followed the rather voluminous literature—it seems to have three dangers. The first is that, in striving for sympathy with nature, we run into sentimentality. The second is that, in avoiding fairy tales, we run into something ten times worse—if indeed fairy tales are bad at all; I mean, a pseudo-psychology of the lower animals. And the third is that, in trying to be exceedingly simple, we become exceedingly inaccurate.

E. B. TITCHENER.

CORNELL UNIVERSITY.

TREE TRUNKS FOUND WITH MASTODON REMAINS.

WHILE excavating the bones of a mastodon near Newburgh, N. Y., as mentioned in SCIENCE, October 10, 1902, there were found large numbers of tree trunks both in the muck and in the marl lying beneath it. In many instances the mastodon bones were found resting on these trees. While most of the trees were so rotten that it was possible to obtain only small fragments, several were recovered in lengths of two feet and over; and one in particular possesses curious interest, and some idea of its probable species would be welcomed by the writer. The tree was lying three feet below the surface, in muck, and was very soft and spongy; and not only on the surface, but clear through, was of a dark brown color, almost that of the muck, and perhaps colored by the muck. Its scientific interest rests upon the fact that in section it is polygonal, while the flat faces of the trunk that make up the polygon vary in number from fourteen to sixteen, some of the faces merging into one another at various points along the trunk. This piece of the tree is about three feet long, and when first dug out, about two months ago, was nearly nine inches thick at one end and six at the other; but it has shrunk on drying out, until now it measures five and three inches, respectively. No other pieces of this tree were found, although the adjoining layers of muck were carefully dug over and examined, in hopes of obtaining more of it.

With one exception, all the other tree trunks found were smaller than this one, few measuring more than five inches at the butt. Some were easily recognized as spruce and red cedar, and were in a fair state of preservation, except that when dry the large amount of shrinkage caused them to crumble unless carefully handled. Several trees showed while still wet the marks of the teeth of animals, and it has been surmised that this was the work of beavers. When dried, however, the tooth marks are much less distinct, and their study is thus rendered more difficult.

REGINALD GORDON.

THE CARNEGIE INSTITUTION.

THE Carnegie Institution shall devote itself essentially to the following subjects:

1st. To moralize scientific men.

2d. To protect investigators settled in countries where proper means be wanting.

3d. To depurate science. How to facilitate that.

4th. To advance science by a selection of studies.

1st. *To moralize scientific men.*

Secure priority of several important researches. Depurate the habits of both institutions and societies. Protect real scientists against upstarts, meddlers, courtiers and

speculators. Independ science from politics and religion. Condemn rivalry between scientists living in hostile countries. Constitute a court of arbitrament where consults be answered, contentions for priority settled, and complaints of subservients nullified by their superiors attended to.

2d. *To protect investigators settled in countries where proper means be wanting.*

Afford them money, laboratories, books and instruments. Establish illustrated publications and print the works of any solicitor, whatever his nationality may be, provided that his writings be important. Scientists are generally obliged to waste their money in order to satisfy editors. Erect libraries and found agencies where scientific books and instruments be sold at the very lowest prices. Science must not remain within the grip of speculators (trading editors and book-sellers).

The Carnegie Institution must not benefit the United States only. Its views must be more absolute; it must protect also those who sacrifice themselves for truth in poor or ignorant countries. Genius is not the exclusive property of the inhabitants of a nation. Establish *international* competitions, rewards, explorations, laboratories, museums, observatories.

3d. *To depurate science. How to facilitate that.*

Make science more popular. Translate many books. Attack the abuse of the nomenclature of natural history (excess of newly discovered species, subspecies, varieties, upper families; unnecessary innovations, an exaggerate dedication to nomenclature *with a view to satisfy vanity*). Study such nomenclatures as to enable everybody to understand technicisms.* Attack the abuse of useless neologisms and their duplication. Unify as much as possible the languages, measures, unities and conventional signs. Publish bibliographies and distribute them freely and *gratuitously* through the world.

4th. *To advance science by a selection of studies.*

Point out the more general and important topics. Set degrees to the value of investigations, repealing that propensity to an isolated and invariable consideration of details (newly discovered subspecies, histological cuts, new stars, lower specialties).

In short, the Carnegie Institution shall not devote itself to discover, but to facilitate the means of discovering to genuine scientists, whatever their nationality may be, constituting itself supporter of the often abused rights of the disinterested investigator or wanting inventor.

A. L. Herrera,
Chief of the Commission of Parasitology, Professor of Biology at the Normal School.
Bettemitas 8, México, D. F.

* A. L. Herrera, 'Nouvelle nomenclature des êtres organisés et des minéraux,' *Mém. Soc. 'Antonio Alzate,'* 1900–1902.

SHORTER ARTICLES.

THE FIRST USE OF MAMMALS AND MAMMALIANS.

In the *Popular Science Monthly* for September, 1902, I have stated that 'the first writer to use the English word mammals to any extent was Doctor John Mason Good,' but could not refer to any of his works earlier than 'The Book of Nature' (1826). His 'Pantologia' was not accessible at the time, but since has been put on the shelves of the library of the U. S. National Museum and on reference to Volume VIII. (1813), I find he formally introduced the English name then, under *Mammalia,* in the following words: "In English we have no direct synonym for this term; quadruped or four-footed, which has usually been employed for this purpose, is truly absurd, since one of the orders have [*sic!*] no feet whatever, and another offers one or two genera, that cannot with propriety be said to have more than two feet. We have hence thought ourselves justified in vernacularizing the Latin term, and translating mammalia, mammals, or breasted-animals."

In Volume XII., in the articles Quadruped and Zoology, Good also used the word *'Mammals' apropos* of the classification of Linnæus and in other places * and, also, in

* The volumes of the 'Pantologia' are not paged, the alphabetical arrangement having been thought to supersede pagination.

the article on 'Quadruped,' the adjective 'mammalian.'

I have already indicated that mammalians had been used in translation of mammifères. The Rev. William Kirby, in 1835, in the once famous Bridgenater treatise 'On the Power, Wisdom and Goodness of God as manifested in the Creation of Animals and in their History, Habits and Instincts,' declined to use the form mammals, but invariably used, as the English equivalent of Mammalia, 'MAMMALIANS.' Chapter XXIV. is entitled 'Functions and Instincts. Mammalians'; in this, it is explained, 'the whole body, constituting the Class, though sometimes varying in the manner, are all distinguished by *giving suck* to their young, on which account they were denominated by the Swedish naturalist, *Mammalians'* (II., p. 476). In a footnote to this statement Kirby adds, 'Cuvier calls them *Mammifers,* but there seems no reason for altering the original term.'

We may cordially endorse the sentiment of Kirby and, doing so, refuse to follow him in action and to adopt his modification of 'the original term,' and revert to the genuine original—mammals or, in the singular, mammal.

No instance of the use of the singular—mammalian—has been found in Kirby's work or in any of his successors', nor does the singular form mammal occur in the 'Pantologia.'

THEO. GILL.

COSMOS CLUB, WASHINGTON.

THE STARTING POINT FOR GENERIC NOMENCLATURE IN BOTANY.

As the subject of generic nomenclature has been considerably discussed of late, perhaps it may not be inappropriate to call particular attention to this phase of it.

The uniformity and permanence of any system of nomenclature must depend largely upon the selection of a proper starting point. The result of the application of any system of fixing genera must vary as the initial date varies. Hence it is of the utmost importance whether we start with Tournefort, Linnæus' 'Genera Plantarum,' 'Species Plantarum,' 'Systema Naturæ' ed. 1, or ed. 10, as one zoological friend has suggested. The starting point must, of course, be fixed more or less arbitrarily, but we believe there are several rational considerations which should influence the selection. Judging from past experience, no date is likely to meet with universal approval at present; but if the date be chosen with proper regard for principles of justice, rationality, and practicability it will stand a reasonable chance of being generally accepted in the future and of leading to that uniformity and stability which are the great desiderata at present. Some one has suggested that to be in accord with these principles we must simply begin at the beginning. To this opinion we heartily subscribe. It is necessary, however, to define just what we mean by 'beginning' and to inquire whether there is anywhere in the course of the development of the conception of genera a point at which genera in anything like a modern sense can be said to have originated. We cannot agree with those who would attribute this 'beginning' to the ancient Greeks or Romans, or even to the mediæval and later herbalists, though they contributed much to the development of the subject and in many instances had rather well-defined ideas of genera. There is, however, no one of them that has defined and illustrated the genera of the vegetable kingdom in general in such a manner as to deserve the title of 'founder of genera,' or as to furnish a practical basis for generic nomenclature. This honor, we believe, is reserved for Tournefort, who in 1700, in his great work 'Institutiones Rei Herbariæ,' described and illustrated in a most admirable manner nearly 700 genera, including members of all the groups of the vegetable kingdom. Here we have, I believe, the earliest practical starting point for generic nomenclature. Many of the systematists of the past have tacitly recognized this fact by crediting Tournefort and his prelinnæan successors, Vailliant, Micheli, and Dillenius with genera established by them. This practice has, however, followed no particular or consistent method.

Let us consider for a moment the claims to recognition of the different initial dates

proposed as compared with Tournefort. Two, —1737 and 1753—are perhaps sufficient to notice; they are practically the only ones that have been used as the basis of serious or systematic efforts to revise our nomenclature. The date of the appearance of the first edition of 'Species Plantarum,' 1753, is very naturally and properly taken as the starting point for specific nomenclature, as this was the first attempt to apply binomials in a systematic manner to a large number of species; but why it should be taken as the date for genera is not so evident. Linnæus's genera were not first described here, but in previous editions of his 'Genera Plantarum.' Hence Kunze's proposition to start with 1737, the date of the first edition of that work, is much more just and logical. But here practical difficulties arise in securing types, as no particular species is mentioned in connection with the generic diagnoses; whereas Tournefort's genera are not only described, but accompanied by lists of described species and excellent illustrations of at least one species of nearly every genus. Why thrust upon Linnæus the honor of founding genera when his most ardent admirers, so far as we are aware, have never claimed it for him?

From the standpoint of the mycologist either 1737 or 1753 is a most absurd date. Linnæus recognized but 11 genera of fungi. These were simply taken from his predecessors and renamed or rearranged. Tournefort described but 7 genera, and from this standpoint alone would have little more claim upon the mycologist than Linnæus. If, however, we have a single starting point for all plant genera, as seems desirable, Tournefort would be far preferable to Linnæus; as it would admit Micheli, one of the greatest mycologists of the eighteenth century, who in 1729, in his great work 'Nova Plantarum Genera,' described 31 genera of fungi, most of which were illustrated with excellent figures. Linnæus himself in his 'Bibliotheca Botanica' pays the following tribute to this acute observer: *Botanicorum vere Lynceus est in examinandis et depingendis minutissimis floribus Muscorum et Fungorum.*

To discard or ignore the work of Micheli, whose only crime was polynomialism, would be a great injustice which we do not believe our posterity would ever uphold. It would be far better to have a separate initial date for fungi than to accept either 1737 or 1753 as a general starting point.

The fact that Tournefort was a polynomialist might suggest itself to some as a possible difficulty. Scarcely any inconvenience need arise from this, however, as whatever species might be selected as the type of the genus, it would bear the oldest specific name it received subsequent to 1753. I fancy the greatest objection of some, however, to 1700 as a starting point, would be the supposed amount of change necessitated. This objection should have very little weight, if future stability and permanency can be secured. No temporary makeshift should be accepted which may involve a minimum of immediate change, but necessitate another revision a few years hence. We should have something which gives reasonable hope of meeting the needs of the present generation at least.

C. L. Shear.

Washington, D. C.

MOSQUITO DEVELOPMENT AND HIBERNATION.

Dr. Harrison G. Dyar's observations upon 'The Eggs of Mosquitoes of the Genus *Culex*,' as given in Science, Vol. XVI., No. 408, are in line with those made by us during the past season. We doubt, however, the wisdom of the divisions into unbanded legged forms depositing eggs in boat-shaped masses, and banded forms depositing singly. We have failed yet to get boat-shaped masses of eggs from any species other than *pipiens* and *consobrinus*.

The matter of the floating of the eggs of mosquitoes is largely one of circumstance, as those of most species, barring, of course, those of the genus *Anopheles*, sink with slight agitation, unless they become attached to drifting débris, common upon most pools in which mosquitoes breed. The facility with which the majority of eggs sink usually warrants delay in hatching, and renders hibernation more than probable in the case of many species.

Agitation seems, in some wáy, associated with hatching. Eggs of many species, after remaining upon the surface of water, or upon the bottom of breeding vessels for days, hatch if removed to a phial and shaken, but if left undisturbed, will remain unhatched for months (in the case of *Conchyliates musicus*, shaking eggs is a favorite way of forcing a hatch). Eggs under similar conditions will hatch if placed in a one per cent. or two per cent. solution of formalin. To determine, under natural conditions, the influence of agitation upon hatching, careful observations were made during the past summer where the water in mosquito pools evaporated and the ponds remained dry for months. As soon as sufficient rain fell, and the disturbances of trickling water were present, larvæ of *Conchyliates musicus, Psorophora ciliata, Psorophora howardii,* and a few species of *Culex,* could be found in the pools a few hours after the rain. This led to the conclusion of a very great irregularity in hatching, and to the belief that the species of *Psorophora* are single-brooded in Louisiana. The eggs of one season hatch irregularly the next. The majority, however, hatch in June, July and August when rainfall is sufficient. Hatchings may occur as late as November, but at this time larvæ are scarce. *Conchyliates musicus* is equally irregular in hatching, though more than one brood a year prevails. We have unhatched eggs of *C. musicus* at the time of this writing that were deposited in July. That they are fertile has been proved by taking some of the same brood at different intervals and forcing a hatch by agitation. Eggs of *Psorophora ciliata* and *P. howardii* deposited in July and August have failed to hatch under such treatment, but the single-brood theory may account for the resistance of the eggs of this genus.

Dr. John B. Smith's conclusions upon the egg-laying habits of *Culex sollicitans,* that of depositing upon marsh grass, certainly must be considered as exceptional, as also his observation of dark (black) eggs in the bodies of dissected specimens. In not a single instance, *sollicitans* included, have we observed a form to deposit dark eggs, nor have we found any to oviposit upon anything but water. Eggs floating about become attached to floating débris just as they do to the sides of vessels in which the water has been allowed to evaporate. Injured specimens will make desperate efforts to reach vessels of water to oviposit, but failing to do so, refuse to lay. We have not found a single species to deposit eggs without water, save a few specimens subjected to the abnormal conditions of mounting for the cabinet, or for study.

From our studies we draw the following conclusions:

1. That boat-shaped masses of eggs are not general.

2. That eggs of most species sink when slightly agitated. Even the eggs of *Culex pipiens* will sink (and hatch) when separated and shaken.

3. That the hatching of the eggs of many species is not at all regular. Pools upon which eggs are laid may dry up and remain so for months, and the fertility of the eggs is in no way impaired. With *Psorophora,* the eggs of one season hatch the next; while with *Conchyliates musicus,* and with many species of *Culex,* eggs laid in the fall remain unhatched all winter. Thus many of our species hibernate in the egg condition. (Eggs of *Stegomyia fasciata,* left high and dry by evaporation, have remained unhatched sixty-one days, and when moistened and agitated, soon hatched.)

4. That the period of larval life may be greatly prolonged by insufficient food and low temperature, and that pupal and adult stages are very much longer late in the season than in midsummer. It is possible for a few adults to hibernate, even of the same species as the hibernating eggs.

5. That it is exceptional for mosquitoes, including *Culex sollicitans,* to deposit eggs upon substances other than water.

6. That it is exceptional for black eggs to be deposited, or for mosquitoes to use their hind legs during egg deposition.

7. That the common breeding places of mosquitoes are transient pools (due as much to the enemies in permanent pools and waterways as anything else), in consequence of which

many species develop rapidly. *Psorophora* and *Conchyliates* may reach maturity in five or six days after hatching.

The above is based upon observation made upon as many as nineteen species.

J. W. DUPREE,
H. A. MORGAN.

LOUISIANA STATE UNIVERSITY,
BATON ROUGE.

THE CONVOCATION OF SCIENTIFIC SOCIETIES.

IT seems scarcely necessary to call attention once more to the meetings of the American Association for the Advancement of Science, the American Society of Naturalists and the special societies which are about to open their sessions at Washington. We have published the announcement of the local committee, and there will be found above some details in regard to the meetings of the societies. We have so often laid stress on the supreme importance of our societies as a factor in the advancement and diffusion of science that it is scarcely possible to say more than has already been said. All our readers know that the national scientific societies have hitherto met in two groups—the American Association and its affiliated societies in the summer and the American Society of Naturalists, with most of the societies devoted to the biological sciences, in the winter. These two great groups of scientific societies will this year meet together during convocation week at the chief scientific center of the country. Under these circumstances the meetings will be the largest and most important ever held on this continent.

SCIENTIFIC NOTES AND NEWS.

DR. GEORGE W. HILL, of Nyack, N. Y., and Professor A. A. Michelson, of the University of Chicago, have been elected foreign members of the Royal Society. The other foreign members elected at the recent annual meeting are: Professor W. C. Brögger, Professor Gaston Darboux, Professor Ewald Hering, Baron Ferdinand von Richthofen, Graf H. zu Solms-Laubach and Professor Julius Thomsen.

M. DESLANDRES, of the astrophysical observatory at Meudon, has been elected a member of the Paris Academy of Sciences in succession to the late M. Faye.

SIR MICHAEL FOSTER has offered his resignation as member of parliament for the University of London.

SIR OLIVER LODGE has been appointed the next Romanes lecturer at Oxford University.

THE German Emperor has conferred the Royal Order of the Crown of Prussia, third class, upon Mr. A. Lawrence Rotch, founder and director of the Blue Hill Observatory, in recognition of his participation in the international work of exploring the atmosphere.

THE subject for the annual discussion before the American Society of Naturalists, which will be held on the afternoon of January 1, is 'How can Endowments be used most Effectively for Scientific Research?' The speakers are Professors T. C. Chamberlin, W. H. Welch, W. M. Wheeler, Franz Boas, J. C. Coulter and Hugo Münsterberg. The public lecture will be given on Tuesday evening by Dr. C. Hart Merriam, his subject being 'Protective and Directive Coloration of Animals, especially in Birds and Mammals.'

DR. ARTHUR W. GOODSPEED, professor of physics at the University of Pennsylvania, has been elected president of the Röntgen Ray Society.

DR. A. H. SMITH has been elected president of the New York Academy of Medicine and and Dr. M. Allen Starr, vice-president.

DR. PEARCE BAILEY has been elected president of the New York Neurological Society.

MR. H. C. RUSSELL, F.R.S., is at present president of the Royal Society of New South Wales, having succeeded Professor A. Liversidge, F.R.S.

IT is reported in foreign papers that Dr. A. Loir, of the Pasteur Institute, Paris, has proceeded to Bulawayo to establish a branch of the Institute there for the treatment of rabies by the anti-rabic inoculation method. Dr. Loir is a nephew of the late M. Pasteur, and has been engaged in the establishment of branches at Sydney, N. S. W., and Tunis.

As we have already stated, Lord Reay has been elected the first president of the newly established British Academy. Mr. I. Gollancz has been elected secretary, and the following have been elected members of the council: Sir W. R. Anson, the Right Hon. James Bryce, Professor I. Bywater, Professor T. W. Rhys Davids, the Rev. Professor S. R. Driver, the Rev. Principal Fairbairn, Sir C. P. Ilbert, K.C.S.I., Sir R. C. Jebb, the Rev. Professor J. E. B. Mayer, Dr. J. A. H. Murray, Professor H. F. Pelham, the Rev. Professor W. W. Skeat, Sir E. Maunde Thompson, Dr. A. W. Ward, Professor James Ward.

MR. HOWARD J. ROGERS, chief of the department of education at the St. Louis Exposition, has been appointed director of the congresses to be held in conjunction with it. An advisory board has been appointed as follows: Chairman, Nicholas Murray Butler, president of Columbia University, New York city; William R. Harper, president of the University of Chicago; R. H. Jesse, president of the University of Missouri; Henry S. Pritchett, president of the Massachusetts Institute of Technology, and Herbert B. Putnam, librarian of Congress.

THE Carnegie Institution has granted $1,600 to Professor E. W. Scripture, of Yale University, for prosecution of researches on the voice.

ACCORDING to the daily papers, the Carnegie Institution has appropriated $5,000 to Professor W. O. Atwater, for his work with the respiration calorimeter, and has made grants, the amount of which is not reported, to the Peabody Museum of Yale University, and to send Dr. H. S. Conrad, fellow in botany at the University of Pennsylvania, to Europe to study varieties of the water-lily.

IN honor of the eightieth birthday of Mrs. Louis Agassiz, president of Radcliffe College, the sum of $116,000 has been collected which will be used for the construction of a students' house at Radcliffe College.

PROFESSOR JOHN O. REED, professor of physics in the University of Michigan, has been injured by an accident due to an explosion in his laboratory. It is feared that his eyesight may be lost.

MR. CHARLES LOUIS POLLARD, of the U. S. National Museum, secretary of the Wild Flower Preservation Society of America, delivered an illustrated lecture on 'Vanishing Wild Flowers,' at the Academy of Sciences of Philadelphia, on December 8, and at Hopkins Hall, Baltimore, on December 19. It is the intention of the society to give information as to its aims and methods of work by means of these lectures in various cities in addition to its distribution of literature. The responses from these two cities have been very gratifying, and indicate that with a wider understanding of the subject public sentiment will be sufficiently aroused to accomplish some practical good in plant protection. The annual meeting of the society will be held in the lecture hall of the National Museum, at Washington, on December 27. On this occasion Professor Francis E. Lloyd, of Teachers College, Columbia University, will lecture on 'The Colors of Flowers.'

DR. H. W. WILEY, president of the Indiana Academy of Science will deliver his presidential address before the academy at Indianapolis, on Friday, December 26. His topic will be 'What Science has Done for Indiana.'

THE Ohio State University Chapter of the Society of the Sigma Xi gave its public meeting of the year on December the eleventh. Professor J. A. Bownocker, who has recently completed an exhaustive study of the great natural gas fields of Ohio, gave the address of the evening under the title 'Natural Gas in Ohio, its Past and Present.'

PROFESSOR E. B. POULTON, F.R.S., will deliver the juvenile lectures at the Society of

Arts this year, his subject being 'Means of Defence in the Struggle for Life among Animals.'

A MEMORIAL tablet to the late Hamilton Y. Castner, the chemist, was unveiled on December 16 at Columbia University, of which he was an alumnus.

MISS LOUISE BRISBIN DUNN, tutor in botany in Barnard College, Columbia University, died suddenly of heart disease early in the morning of December 18. She was a graduate of Barnard and since her graduation has been a member of the teaching staff.

WE regret also to record the deaths of Professor Ladislava Celakovského, professor of botany in the Bohemian University at Prague, at sixty-nine years of age; of Dr. George Thoms, professor of agricultural chemistry at the Polytechnic School at Riga, at the age of sixty years; of Dr. Ernst Meynert, associate professor of anatomy at the University of Halle, at the age of thirty-nine years; and of Dr. M. Wilde, docent in hygiene at the University at Munich, at the age of thirty-two years.

THE Archeological Institute of America will meet at Princeton on December 31 and January 1 and 2.

A CIVIL service examination will be held on January 27 for the position of chemical clerk in the food laboratory of the Bureau of Chemistry, Department of Agriculture. The salary is $600, and the position is open to either men or women.

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AT the convocation exercises of the University of Chicago it was announced that Mr. John D. Rockefeller had given $1,000,000 to be added to the endowment, and that other sums amounting to $526,000 had been given to the university.

THE Medical Department of Tulane University has been made the residuary legatee of the late A. C. Hutchinson, and it is expected that it will receive from the estate about $1,000,000.

MRS. MARY M. ADAMS, widow of the late Charles Kendall Adams, the president of the University of Wisconsin, has left the University a large part of her estate. This will be added to the fellowship fund, created by the will of President Adams. The bequest includes the library of President Adams.

THE University of Rochester has received a gift of $10,000 from Mrs. Esther Baker Steele.

SENN HALL, of the Rush Medical College, was dedicated on December 17, the principal address being made by Sir William Hingston, professor of surgery in Laval University, Montreal. The building has been erected at a cost of $130,000 towards which Dr. Senn gave $30,000.

THE corner stone of the gymnasium of Stanford University, which the daily papers state will cost $500,000, was laid on December 11.

THE erection of the Scott Hall of Natural Science of Wesleyan University will be begun in the spring. The building is 120 x 50 ft., with an extension 49 x 28 ft.

WE are requested to call attention again to the dinner to be given to the Association of American Universities in New York City on December 30, tickets for which can be obtained by the alumni of the universities represented in the association on application to Professor B. D. Woodward, Columbia University, New York City. President Butler, of Columbia, will preside, and speeches will be made by President Eliot, of Harvard; President Hadley, of Yale; Mr. James W. Alexander and the Honorable Wayne MacVeagh.

AN appeal has been made by New York University to the Court of Appeals from the decision of the Appellate Division which awarded to the Medical College Laboratory of the City of New York the premises which were deeded over to the university in 1897 by the Medical College Laboratory of the City of New York under a plan to combine the university and the laboratory.

DR. OBERHUMMER, professor of geography at Munich, has been called to Vienna.

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